# HUMAN BIOLOGY

## a record of research

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# HUMAN BIOLOGY

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# HUMAN BIOLOGY

## a record of research

**SEPTEMBER, 1932**

# STUDIES IN GROWTH

BY FRANZ BOAS

The general growth curve of man has long been known, but we have little evidence in regard to the growth of individuals who ultimately reach various statures. For this purpose it is necessary to follow the individual growth from childhood to the adult stage. Some material of this kind has been collected, but not enough to give an adequate insight into the phenomena.

Two problems present themselves at once. The one is the question how individuals differing in adult stature grow, the other how retardation or acceleration of bodily development affects the growth curve.[1]

I am indebted to Professor Wilson Farrand, Director of the Newark Academy, to Prof. F. A. Woll of City College, to Mrs. McCastline of Horace Mann School, and to Mr. Lewis, Superintendent of the Ethical Culture Schools, all of New York, for the material used in the following study. The records of Horace Mann School were supplemented by college records of those students whose choice of college could be traced. The gymnasia of the various colleges placed copies of their records at my disposal. The calculations of the material were made by Mrs.

[1] I have shown in *Science*, 19 (1892), pp. 256; 281; 20 (1892), p. 351; that the increase of the variability during adolescence and its later decrease must be explained by the varying distribution of acceleration and retardation of growth. Later I emphasized the same point in a review of William Townsend Porter's investigations on the growth of St. Louis children (*Correspondenz-Blatt der Deutschen anthropologischen Gesellschaft*, 1895, pp. 41-46); also in a review of Henry G. Beyer, The Growth of Naval Cadets, *Science*, N. S., 2 (1895), p. 344. I have also shown that the asymmetries of the curves of distribution and the increased correlation between stature and weight are due to this cause. (See Report of the U. S. Commissioner of Education for 1896-97, p. 1552; and *Ibid.* Report for 1904, pp. 25 *et seq.*)

Estelle Fine Ritt and Miss Bertha Cohen. To all of these I express my sincere thanks.

It has been easier to trace girls up to adult life than boys because their growth period is shorter. Hence the discussion is based principally on the growth of the female.

### RETARDATION AND ACCELERATION OF GROWTH

The first problem investigated is that of the influence of retardation and acceleration upon the growth curve. The observation that a child of a certain age has a certain stature does not tell us whether the observed value is due to heredity or to a rapid or slow rate of growth which may depend upon genetic or environmental conditions. It is necessary to find criteria that will enable us to tell whether the state of physiological development of the individual is normal, retarded or accelerated, and whether the rate of physiological development is genetically or environmentally determined.

Two criteria in the material at my disposal were available for this study, the date of first menstruation and the period of maximum rate of growth. It is well known that from birth on this rate decreases until at the period of adolescence a sudden increase sets in, followed by a rapid decrease, which continues until the maximum stature is reached.

The first task was the determination of the distribution of the dates when these two phenomena occur. It has often been claimed that there are racial differences in the time of reaching sexual maturity. For this reason I divided the Horace Mann School girls into two groups, Hebrew and non-Hebrew. The division is approximate only, as I had to be guided entirely by names. For this reason some Hebrew girls are probably included in the non-Hebrew group. The results are given in Table 1.[2] It will be seen that there is practically no difference between the two groups. The third column in the table contains data on girls in the Hebrew Orphan Asylum.

[2] The series of Horace Mann School pupils contains 31 pairs of sisters. The average age at first menstruation of the older sisters is 13 y. 0.4 months ± 13.0 months; that of the younger sisters 12 y. 8.1 months; the coefficient of correlation + .4. The series of Horace Mann School and Newark Academy boys contain 64 pairs of brothers. The average age for maximum rate of growth of the elder brothers is 14y. 4.8 months ± 12.1 months; that of the younger brothers 14y. 2.4 months ± 12.0 months. The coefficient of correlation is + .34.

TABLE 1

*Age at First Menstruation*

| AGE | HORACE MANN SCHOOL Hebrew | Non-Hebrew | HEBREW ORPHAN ASYLUM |
|---|---|---|---|
| 10y 0m—less than 10y 3m..... | — | 1 | — |
| 10y 3m— " " 10y 6m..... | — | 1 | — |
| 10y 6m— " " 10y 9m..... | 3 | 2 | 1 |
| 10y 9m— " " 11y 0m..... | 1 | 4 | 1 |
| 11y 0m— " " 11y 3m..... | 3 | 3 | 2 |
| 11y 3m— " " 11y 6m..... | 2 | 2 | 3 |
| 11y 6m— " " 11y 9m..... | 8 | 14 | 3 |
| 11y 9m— " " 12y 0m..... | 3 | 11 | 10 |
| 12y 0m— " " 12y 3m..... | 9 | 18 | 5 |
| 12y 3m— " " 12y 6m..... | 10 | 15 | 11 |
| 12y 6m— " " 12y 9m..... | 11 | 18 | 6 |
| 12y 9m— " " 13y 0m..... | 7 | 24 | 20 |
| 13y 0m— " " 13y 3m..... | 4 | 21 | 14 |
| 13y 3m— " " 13y 6m..... | 13 | 26 | 12 |
| 13y 6m— " " 13y 9m..... | 9 | 16 | 15 |
| 13y 9m— " " 14y 0m..... | 6 | 10 | 18 |
| 14y 0m— " " 14y 3m..... | 5 | 8 | 16 |
| 14y 3m— " " 14y 6m..... | 5 | 10 | 15 |
| 14y 6m— " " 14y 9m..... | 4 | 7 | 12 |
| 14y 9m— " " 15y 0m..... | 6 | 5 | 7 |
| 15y 0m— " " 15y 3m..... | 3 | 4 | 5 |
| 15y 3m— " " 15y 6m..... | 2 | 5 | 2 |
| 15y 6m— " " 15y 9m..... | 1 | 6 | 4 |
| 15y 9m— " " 16y 0m..... | — | 1 | 3 |
| 16y 0m— " " 16y 3m..... | 1 | 3 | — |
| 16y 3m— " " 16y 6m..... | — | — | — |
| 16y 6m— " " 16y 9m..... | — | — | — |
| 16y 9m— " " 17y 0m..... | — | 1 | — |
| Total Number ..... | 116 | 236 | 185 |
| Average and $\sigma$ ..... | 13.1 ± 1.2 ys. | 13.1 ± 1.2 ys. | 13.5 ± 1.1 ys. |

In the classification of the material according to maximum rate of growth difficulties are encountered. Since the dates of measurement were irregularly distributed, ranging between about six months and a year and a half, it was necessary to interpolate for full year intervals. This was done so that the stature used corresponded to the full completed year. It will be understood that the measurements as taken are not sufficiently accurate for our purpose and that with greater accuracy

and consideration of seasonal variations in growth the results would be slightly altered. With the available data nothing better could be obtained. The results are given in Table 2.

TABLE 2

*Age of Maximum Rate of Growth of Girls: Horace Mann School*

| AGE OF MAXIMUM RATE OF GROWTH *Years* | NON-HEBREW GIRLS (295 cases) | HEBREW GIRLS (188 cases) |
|---|---|---|
| 9-10 | 9 | 5 |
| 10-11 | 44 | 22 |
| 11-12 | 101 | 61 |
| 12-13 | 86 | 63 |
| 13-14 | 49 | 36 |
| 14-15 | 5 | 1 |
| 15-16 | 1 | — |
| Average and $\sigma$ | 12.0 ± 1.2 ys. | 12.1 ± 1.2 ys. |

For boys the distribution of periods of maximum growth is as follows:

TABLE 2a

*Age of Maximum Rate of Growth of Boys*

| INTERVAL *Years* | NEWARK ACADEMY (312 cases) | CITY COLLEGE (254 cases) |
|---|---|---|
| 11-12 | 7 | (?) |
| 12-13 | 20 | (?) |
| 13-14 | 74 | 29 |
| 14-15 | 129 | 117 |
| 15-16 | 64 | 87 |
| 16-17 | 18 | 21 |
| Average and $\sigma$ | 14.4 ± 1.1 | 14.7 ± 1.1 * |

* Approximate allowance is made for the absence of the early groups which are not contained in the data, since the observations begin with 12 years.

Notwithstanding the difference in descent the two groups of girls in the Horace Mann School agree in the age of maturity and maximum rate of growth, while the differences for the social groups seem to be significant. The Hebrew Orphan Asylum girls have their first menstruation .4 ± .1 year later than the Horace Mann School girls. The City

College boys have their period of maximum growth .3 ± .09 years later than the Newark Academy boys.

The social environment of all the Horace Mann School students, Hebrew and Non-Hebrew, is very much alike and we may infer from our data that the racial influence, whatever it may be, is insignificant as compared to the social factor. This agrees with previous statistics which show very considerable differences between social classes regarding the time of first menstruation.[3]

The age of maximum rate of growth precedes the date of first menstruation by just one year.

On account of the sameness of the two series from Horace Mann School I have combined them in most of the following studies.

It would be interesting to know the variations of the interval between time of maximum growth and first menstruation. On account of the uncertainty of the exact period of maximum rate of growth, this value cannot be given. The average interval decreases with increasing age of maximum growth.

TABLE 3

*Average Interval Between Maximum Growth and First Menstruation for Different Ages of Maximum Growth*

| AGE OF MAXIMUM GROWTH *Years* | AVERAGE INTERVAL BETWEEN MAXIMUM GROWTH AND FIRST MENSTRUATION *Months* |
|---|---|
| 9-10 | + 27.3 |
| 10-11 | + 18.7 |
| 11-12 | + 13.2 |
| 12-13 | + 12.6 |
| 13-14 | + 11.7 |

## TOTAL PERIOD OF GROWTH AND TIME OF ADOLESCENCE

Next I investigated the extent of the total period of growth in relation to the time of adolescence. On account of the inaccuracy of the measurements I have assumed that a total growth of less than 1 cm. from a certain year on means practically completion of growth.

[3] See literature, for instance, in Ferd. Frhr. v. Reitzenstein, Das Weib; 11TH Ed. 1927. (Revised edition of H. Ploss, Das Weib), Vol. 1, pp. 671 *et seq.*

TABLE 4a

*Percentage of Horace Mann School Girls Who Cease Growing at a Given Age*

| DATE OF FIRST MENSTRUATION | AGE AT WHICH GROWTH CEASES | | | | CASES | YEAR OF MAX. GROWTH | AGE AT WHICH GROWTH CEASES | | | | CASES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14 | 15 | 16 | 17 and later | | | 14 | 15 | 16 | 17 and later | |
| 10-11 | 50 | 50 | — | — | (13) | 10-11 | 0 | 32 | 45 | 23 | (22) |
| 11-12 | 0 | 27 | 56 | 17 | (59) | 11-12 | 2 | 32 | 41 | 25 | (65) |
| 12-13 | 6 | 40 | 27 | 27 | (103) | 12-13 | 0 | 3 | 50 | 47 | (74) |
| 13-14 | 10 | 3 | 38 | 49 | (181) | 13-14 | 0 | 0 | 33 | 67 | (43) |
| 14-15 | 0 | 5 | 40 | 55 | 104 | Average Stature | | 161.2 | 162.6 | 163.1 | 163.5* |
| 15-16 | 0 | 0 | 15 | 85 | 45 | | | (30) | (88) | (66) | (20) |

* 18 and later.

TABLE 4b

*Percentage of Boys Who Cease Growing at a Given Age*

| *Newark Academy* | | | | | *City College* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| YEAR OF MAX. GROWTH | AGE AT WHICH GROWTH CEASES | | | | YEAR OF MAX. GROWTH | AGE AT WHICH GROWTH CEASES | | | |
| | 17 | 18 | 19 | 20 and later | | 17 | 18 | 19 | 20 and later |
| 13-14 | 0 | 100 | — | — | 13-14 | 45 | 41 | 9 | 5 |
| 14-15 | 0 | 33 | 47 | 20 | 14-15 | 9 | 55 | 24 | 12 |
| 15-16 | 0 | 30 | 30 | 40 | 15-16 | 0 | 17 | 66 | 17 |
| 16-17 | 0 | 0 | 0 | 100 | 16-17 | 0 | 0 | 60 | 40 |

The striking difference between the two tables for Newark Academy and City College is due to the fact that I had the adult stature of former students of Newark Academy taken ten years and more after their graduation, while the City College records end with twenty years. The total amount of growth after twenty years, which is not negligible, is therefore lacking in the City College tabulation and it may well be that the large percentages of those who apparently stopped growing at 17, 18, and 19 years would disappear if the additional amount of growth after 20 years were known.

It appears from this table that the later maturity sets in, the longer is the period of growth. The completion of growth of girls whose first menstruation occurs in a given year takes place at approximately the same time as that of girls whose maximum rate of growth occurs one year earlier.

STATURE OF HEBREWS AND NON-HEBREWS

A comparison of the average statures of the whole group of Hebrew and non-Hebrew girls shows throughout a slight excess for the latter group. (Table 5, Fig. 1). This agrees partly with results previously

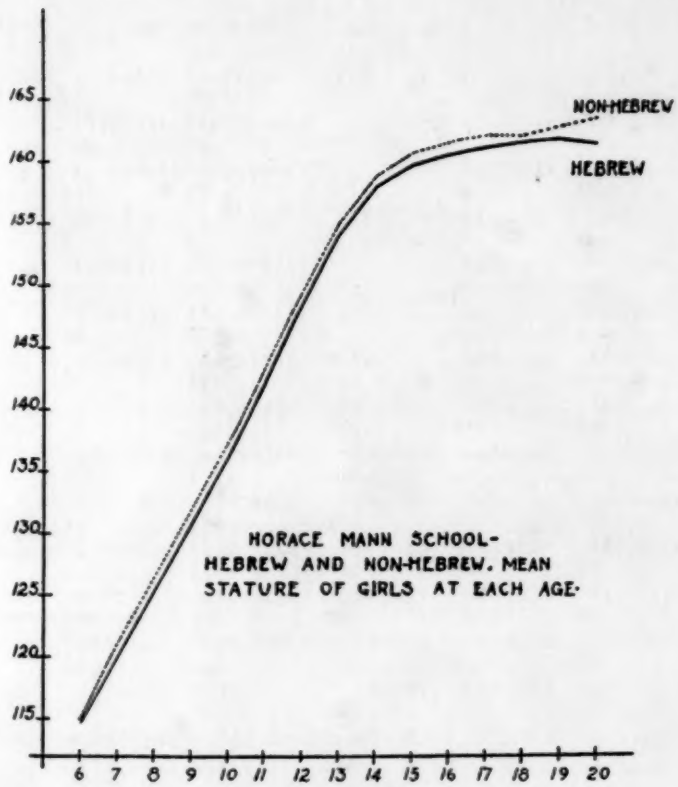


FIG. 1

obtained through a study of the growth of boys and girls in the Ethical Culture School, in the Newark Academy, in the Public Schools and in the Hebrew Orphan Asylum. I repeat the comparative table here to which new materials have been added (Table 5). The original table was published in "The Growth of Children as Influenced by Environmental and Hereditary Conditions," *School and Society*, 17, (1923), pp.

TABLE 5a

*Mean and Sigma of Stature—Boys—Comparative Table*

| AGE | HEBREW | | AMERICAN PRIVATE SCHOOL | HEBREW GENERAL POPULATION | | CITY COLLEGE |
|---|---|---|---|---|---|---|
| Yrs. | Orphans | Private School | | American Born | Foreign Born | |
| 1 | ..... | ..... | ..... | (74.7±5.5) 21 | (83.5±6.5) 2 | ..... |
| 2 | ..... | ..... | ..... | 86.5±4.3 27 | 94.5±0.5 2 | ..... |
| 3 | ..... | ..... | ..... | 96.0±4.3 28 | 92.0±3.3 3 | ..... |
| 4 | 99.8±6.1 140 | ..... | ..... | 100.2±8.2 30 | 101.3±4.5 7 | ..... |
| 5 | 105.6±5.6 301 | 112.0±4.8 40 | ..... | 104.7±5.6 59 | 102.0±5.8 22 | ..... |
| 6 | 110.6±6.6 398 | 118.6±4.6 86 | ..... | 110.1±5.4 14 | 108.1±5.8 23 | ..... |
| 7 | 116.2±6.2 321 | 122.7±4.8 105 | ..... | 115.1±5.3 60 | 114.3±6.2 24 | ..... |
| 8 | 121.3±5.9 233 | 128.6±5.6 130 | ..... | 122.1±5.7 77 | 120.1±6.3 34 | ..... |
| 9 | 125.9±6.1 204 | 133.1±5.8 138 | 130.7±5.5 70 | 127.1±5.5 138 | 125.2±5.0 56 | ..... |
| 10 | 130.6±6.7 190 | 137.3±6.4 168 | 135.3±5.3 176 | 131.5±6.3 273 | 129.3±5.6 87 | ..... |
| 11 | 136.2±6.9 133 | 142.0±7.1 174 | 139.7±5.7 324 | 135.9±7.0 323 | 135.6±5.8 120 | ..... |
| 12 | 140.4±6.1 108 | 146.0±7.1 200 | 144.4±6.4 461 | 140.6±6.9 383 | 138.1±6.0 141 | 144.9±7.1 89 |
| 13 | 146.0±8.4 54 | 151.1±8.6 208 | 149.6±7.6 562 | 145.8±7.7 353 | 144.0±7.5 143 | 150.4±7.8 392 |
| 14 | 151.4±7.6 48 | 157.1±9.4 225 | 155.8±8.5 642 | 152.4±8.4 341 | 150.5±7.9 124 | 156.3±8.4 755 |
| 15 | ..... | 162.8±9.1 153 | 162.6±8.5 625 | 155.3±7.4 224 | 154.7±8.7 95 | 162.4±8.0 847 |
| 16 | ..... | 166.9±8.1 143 | 168.0±7.5 621 | 159.8±7.9 32 | 159.0±5.9 36 | 166.7±7.2 879 |
| 17 | ..... | 166.7±8.1 19 | 171.2±6.4 516 | 164.6±6.7 15 | 163.6±6.6 25 | 168.8±6.8 894 |
| 18 | ..... | ..... | 172.6±6.2 410 | 168.8±5.5 6 | 164.3±4.9 25 | 169.8±6.7 852 |
| 19 | ..... | ..... | 173.4±5.9 274 | 167.8±3.6 6 | 165.1±6.1 32 | 169.8±6.7 641 |
| 20 | ..... | ..... | 174.0±5.7 169 | 167.2±6.6* 38 | 164.3±5.8* 890 | 168.8±6.8 350 |
| 21 | ..... | ..... | 174.7±5.5 99 | ..... | ..... | 167.8±6.0 161 |
| 22 | ..... | ..... | ..... | ..... | ..... | 167.9±6.4 70 |
| 23 | ..... | ..... | ..... | ..... | ..... | 166.6±6.4 33 |

* 20 years old and over.

TABLE 5b

*Mean and Sigma of Stature—Girls—Comparative Table*

| AGE | HEBREW | | HEBREW GENERAL POPULATION | | HORACE MANN SCHOOL | |
|---|---|---|---|---|---|---|
| Yrs. | Orphans | Private School | American Born | Foreign Born | Hebrew | Non-Hebrew |
| 1 | ..... | ..... | (78.4±7.7) 18 | ..... | ..... | ..... |
| 2 | ..... | ..... | 86.3±6.7 30 | ..... | ..... | ..... |
| 3 | ..... | ..... | 91.5±5.8 11 | 89.2±3.2 5 | ..... | ..... |
| 4 | ..... | ..... | 100.2±5.2 38 | 99.7±3.3 5 | ..... | ..... |
| 5 | 103.6±5.7 328 | 109.5±5.0 28 | 104.1±5.6 52 | 103.2±5.5 17 | ..... | ..... |
| 6 | 109.5±5.7 372 | 116.3±5.1 84 | 110.2±5.9 59 | 107.3±5.4 17 | 114.8±4.7 60 | 115.0±4.4 109 |
| 7 | 114.3±6.4 330 | 122.2±5.6 108 | 115.4±5.2 61 | 113.1±7.7 23 | 120.0±5.0 103 | 121.1±4.7 166 |
| 8 | 119.6±6.1 252 | 127.0±5.7 117 | 121.6±5.2 49 | 119.3±6.9 37 | 125.3±5.1 135 | 126.5±5.1 205 |
| 9 | 125.0±6.1 209 | 131.8±6.0 122 | 124.1±6.6 39 | 123.9±7.1 32 | 130.8±6.0 166 | 131.8±5.4 254 |
| 10 | 129.5±6.8 164 | 137.4±6.7 123 | 129.9±6.4 53 | 129.1±7.0 44 | 136.2±6.2 190 | 137.3±6.0 302 |
| 11 | 135.4±7.2 170 | 143.0±6.8 135 | 135.1±5.6 38 | 134.4±7.4 36 | 142.0±6.6 215 | 143.3±6.6 341 |
| 12 | 141.2±7.8 120 | 149.4±6.8 146 | 141.9±6.9 55 | 141.6±8.0 34 | 148.5±7.3 240 | 149.6±7.0 398 |
| 13 | 145.0±7.3 71 | 154.2±6.4 154 | 149.1±6.4 33 | 147.5±5.8 40 | 154.3±7.0 266 | 155.3±6.7 461 |
| 14 | 150.9±4.5 32 | 156.7±5.9 142 | 153.5±6.0 37 | 152.2±5.9 34 | 158.2±6.3 288 | 159.2±6.2 524 |
| 15 | 150.9±5.7 11 | 158.5±5.8 137 | 154.0±5.8 27 | 155.3±6.4 24 | 160.0±6.1 299 | 161.0±5.8 558 |
| 16 | ..... | 159.0±6.0 122 | 155.2±5.7 19 | 155.1±4.7 40 | 160.9±6.2 296 | 161.9±5.9 539 |
| 17 | ..... | 159.0±5.8 84 | 156.4±5.0 14 | 155.6±4.8 58 | 161.6±6.3 256 | 162.5±6.0 478 |
| 18 | ..... | 160.0±5.6 35 | 158.4±7.3* 67 | 154.9±5.8* 1119 | 162.0±6.5 173 | 162.5±5.8 288 |
| 19 | ..... | 161.0±5.6 25 | ..... | ..... | 162.3±6.1 87 | 163.4±5.2 141 |
| 20 | ..... | 160.0±5.5 22 | ..... | ..... | 161.9±5.7 59 | 164.0±5.1 89 |

* 18 years old and over.

305-308. Additional materials included in this table are series of boys and girls in private schools. The general Hebrew population contains

materials published in Boas, F., Descendants of Immigrants, Columbia University Press, 1912, pp. 246, 247, together with materials obtained with a grant from the Bache Fund of the National Academy of Sciences. The year indicates the interval from birthday to birthday and represents approximately the midyear point.

In the two series, that of Hebrew boys in a private school and that of Newark Academy boys, the young Hebrew boys up to the thirteenth year exceed in stature while later on they lag. A similar phenomenon is found in a comparison of the City College and Newark Academy boys (Table 5), at least in so far as the 12-14 years old boys in City College are slightly taller than those in Newark Academy while later on they lag.

A detailed comparison of the City College boys—mostly Hebrew—and the Newark boys based on those who have the same stature at 12, 13, and 14 years, shows a similar phenomenon (Table 6), in so far as

TABLE 6a

*City College and Newark Academy Boys Increments of Stature for Those With Same Stature at 12 Years. The Second Column Under Each Heading in Table 6 Represents the Number of Observed Cases*

| STATURE AT 12 YRS. | INCREMENT | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12-13 yrs. | | 12-14 | | 12-15 | | 12-16 | | 12-17 | | 12-18 | | |
| 125- | 3.0 | 3 | 7.0 | 3 | 14.7 | 3 | 24.3 | 3 | 31.0 | 1 | 35.0 | 1 | N. A. |
| 129.9 | 4.5 | 1 | 11.6 | 1 | 19.0 | 1 | 22.9 | 1 | 24.3 | 1 | | | C. C. |
| 130- | 4.3 | 24 | 9.7 | 22 | 16.9 | 15 | 25.3 | 14 | 30.0 | 11 | 32.1 | 7 | N. A. |
| 134.9 | 6.9 | 8 | 14.0 | 8 | 20.3 | 8 | 25.1 | 8 | 27.7 | 7 | 29.4 | 6 | C. C. |
| 135- | 4.6 | 66 | 10.6 | 61 | 17.6 | 51 | 23.5 | 39 | 28.6 | 23 | 31.3 | 10 | N. A. |
| 139.9 | 5.9 | 14 | 13.5 | 14 | 20.1 | 13 | 24.7 | 14 | 27.3 | 12 | 29.1 | 11 | C. C. |
| 140- | 5.5 | 128 | 12.1 | 109 | 19.3 | 94 | 24.8 | 69 | 28.3 | 47 | 30.8 | 24 | N. A. |
| 144.9 | 6.5 | 24 | 13.2 | 24 | 19.8 | 24 | 22.8 | 20 | 24.8 | 19 | 25.6 | 17 | C. C. |
| 145- | 5.3 | 117 | 12.1 | 106 | 19.3 | 85 | 25.0 | 73 | 27.9 | 40 | 28.8 | 19 | N. A. |
| 149.9 | 5.9 | 23 | 12.8 | 22 | 18.5 | 21 | 22.4 | 22 | 24.9 | 20 | 25.2 | 16 | C. C. |
| 150- | 6.7 | 61 | 13.5 | 51 | 20.3 | 40 | 24.4 | 29 | 27.1 | 15 | 29.5 | 6 | N. A. |
| 154.9 | 5.5 | 12 | 11.9 | 12 | 18.9 | 12 | 23.2 | 11 | 25.3 | 9 | 26.0 | 9 | C. C. |
| 155- | 7.9 | 15 | 14.8 | 13 | 20.7 | 11 | 24.5 | 8 | 26.8 | 4 | 24.0 | 1 | N. A. |
| 159.9 | 6.2 | 4 | 10.8 | 4 | 14.3 | 4 | 17.2 | 3 | 20.4 | 2 | 29.0 | 1 | C. C. |
| 160- | 5.5 | 4 | 6.3 | 3 | 11.3 | 3 | 12.5 | 2 | 14.0 | 2 | 9.0 | 1 | N. A. |
| 164.9 | 7.2 | 3 | 15.0 | 3 | 20.3 | 3 | 22.5 | 2 | 22.8 | 1 | 23.5 | 1 | C. C. |

Average—Newark Academy at 12 years—144.4 cm.
City College at 12 years—144.9 cm.

TABLE 6b

*City College and Newark Academy Boys Increments of Stature for Those With Same Stature at 13 Years*

| STATURE AT 13 YRS. | INCREMENT | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12-13 yrs. | | | | 13-14 | | | | 13-15 | | | | 13-16 | | | | 13-17 | | | | 13-18 | | | |
| 125-129.9 | 3.0 | 1 | | | 4.0 | 2 | | | 8.0 | 2 | | | 14.0 | 1 | | | 18.0 | 1 | | | 19.0 | 1 | N. | A. |
| | | | | | 3.5 | 1 | | | 8.1 | 1 | | | 13.7 | 1 | | | 20.2 | 1 | | | 26.1 | 1 | C. | C. |
| 130-134.9 | 3.2 | 6 | | | 4.5 | 11 | | | 10.3 | 9 | | | 19.1 | 8 | | | 25.0 | 7 | | | 28.5 | 4 | N. | A. |
| | 4.5 | 1 | | | 4.9 | 5 | | | 10.9 | 5 | | | 16.9 | 5 | | | 21.1 | 5 | | | 24.2 | 4 | C. | C. |
| 135-139.9 | 3.6 | 32 | | | 5.3 | 42 | | | 12.3 | 33 | | | 19.5 | 27 | | | 24.2 | 17 | | | 27.6 | 10 | N. | A. |
| | 4.8 | 5 | | | 6.6 | 30 | | | 14.5 | 30 | | | 20.7 | 30 | | | 23.5 | 26 | | | 25.3 | 23 | C. | C. |
| 140-144.9 | 4.4 | 61 | | | 6.1 | 80 | | | 13.5 | 68 | | | 19.9 | 55 | | | 24.3 | 36 | | | 26.7 | 21 | N. | A. |
| | 5.2 | 13 | | | 7.6 | 60 | | | 14.7 | 59 | | | 20.2 | 60 | | | 23.2 | 51 | | | 24.4 | 41 | C. | C. |
| 145-149.9 | 5.0 | 118 | | | 6.4 | 138 | | | 13.6 | 119 | | | 19.5 | 99 | | | 23.5 | 68 | | | 25.4 | 41 | N. | A. |
| | 5.7 | 21 | | | 7.0 | 89 | | | 13.9 | 89 | | | 18.5 | 83 | | | 20.9 | 72 | | | 22.2 | 66 | C. | C. |
| 150-154.9 | 5.5 | 111 | | | 7.2 | 132 | | | 14.1 | 109 | | | 19.0 | 87 | | | 21.5 | 58 | | | 23.5 | 30 | N. | A. |
| | 6.1 | 28 | | | 6.8 | 99 | | | 13.1 | 99 | | | 17.0 | 98 | | | 18.9 | 87 | | | 20.0 | 76 | C. | C. |
| 155-159.9 | 6.5 | 50 | | | 7.2 | 64 | | | 14.4 | 55 | | | 18.7 | 44 | | | 20.7 | 30 | | | 21.9 | 15 | N. | A. |
| | 7.4 | 13 | | | 7.4 | 65 | | | 13.4 | 64 | | | 16.5 | 63 | | | 17.8 | 58 | | | 18.6 | 55 | C. | C. |
| 160-164.9 | 8.3 | 29 | | | 7.5 | 30 | | | 13.8 | 24 | | | 16.4 | 21 | | | 18.8 | 11 | | | 18.8 | 5 | N. | A. |
| | 7.0 | 3 | | | 6.5 | 27 | | | 11.2 | 27 | | | 13.6 | 27 | | | 14.4 | 27 | | | 15.6 | 22 | C. | C. |
| 165-169.9 | 8.8 | 8 | | | 5.5 | 10 | | | 8.3 | 9 | | | 10.3 | 6 | | | 7.5 | 2 | | | 7.5 | 2 | N. | A. |
| | 8.0 | 4 | | | 5.6 | 11 | | | 9.0 | 11 | | | 10.4 | 9 | | | 10.3 | 7 | | | 10.8 | 7 | C. | C. |
| 170-174.9 | 13.7 | 3 | | | 4.0 | 2 | | | 7.0 | 2 | | | 6.0 | 1 | | | | | | | | | N. | A. |
| | | | | | 3.2 | 1 | | | 4.2 | 1 | | | 4.6 | 1 | | | 4.6 | 1 | | | 4.7 | 1 | C. | C. |

Average—Newark Academy at 13 years—149.4 cm.
City College at 13 years—150.4 cm.

the young and short City College boys grow more than the Newark Academy boys. This period of excess for City College boys lasts the longer, the shorter the boys at the initial period. The earlier excess of the tall Newark Academy group over the tall City College group may be accounted for by the greater physiological age of these groups, for on the average the period of maximum rate of growth of tall boys will be earlier than that of short ones of the same age.

A comparison of the statures of the Hebrew and non-Hebrew Horace Mann School girls, arranged according to the time of maximum rate of growth, shows on the whole slight differences in favor of the

TABLE 6c

*City College and Newark Academy Boys Increments of Stature for Those With Same Stature at 14 Years*

| STATURE AT 14 YRS. | INCREMENT | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12-14 yrs. | | 13-14 | | 14-15 | | 14-16 | | 14-17 | | 14-18 | | |
| 125- } 129.9 } | | | | | 6.8 | 1 | 11.6 | 1 | 20.3 | 1 | 26.8 | 1 | N. A. |
| 130- } | 7.0 | 1 | 4.0 | 2 | 4.7 | 3 | 12.0 | 2 | 18.0 | 2 | 21.0 | 2 | N. A. |
| 134.9 } | | | 2.6 | 2 | 4.6 | 4 | 11.2 | 4 | 18.3 | 4 | 23.3 | 4 | C. C. |
| 135- } | 7.0 | 6 | 4.3 | 11 | 5.9 | 14 | 13.2 | 12 | 20.1 | 9 | 24.0 | 6 | N. A. |
| 139.9 } | | | 4.0 | 5 | 5.9 | 12 | 12.4 | 12 | 18.0 | 12 | 21.1 | 12 | C. C. |
| 140- } | 8.1 | 32 | 4.5 | 41 | 6.2 | 37 | 13.2 | 29 | 19.5 | 19 | 22.9 | 12 | N. A. |
| 144.9 } | 10.7 | 7 | 5.3 | 22 | 7.6 | 48 | 14.1 | 48 | 18.0 | 45 | 20.3 | 11 | C. C. |
| 145- } | 9.2 | 41 | 5.1 | 65 | 7.0 | 75 | 14.1 | 60 | 19.1 | 36 | 22.8 | 18 | N. A. |
| 149.9 } | 9.9 | 7 | 6.1 | 38 | 7.4 | 107 | 13.5 | 108 | 17.0 | 101 | 18.7 | 92 | C. C. |
| 150- } | 10.6 | 74 | 6.0 | 107 | 7.3 | 122 | 13.7 | 108 | 17.6 | 75 | 19.1 | 48 | N. A. |
| 154.9 } | 12.7 | 18 | 6.8 | 82 | 7.0 | 152 | 12.1 | 150 | 14.8 | 134 | 15.9 | 110 | C. C. |
| 155- } | 12.4 | 100 | 6.9 | 124 | 7.3 | 119 | 12.5 | 93 | 15.5 | 62 | 17.2 | 38 | N. A. |
| 159.9 } | 12.7 | 22 | 7.3 | 99 | 6.7 | 185 | 10.8 | 180 | 12.8 | 164 | 13.9 | 149 | C. C. |
| 160- } | 13.7 | 66 | 7.8 | 95 | 6.9 | 97 | 10.8 | 77 | 12.6 | 52 | 13.6 | 31 | N. A. |
| 164.9 } | 13.3 | 20 | 7.3 | 75 | 5.7 | 125 | 8.6 | 123 | 9.8 | 118 | 10.4 | 104 | C. C. |
| 165- } | 15.6 | 28 | 8.3 | 37 | 5.3 | 43 | 7.8 | 39 | 8.9 | 28 | 7.9 | 13 | N. A. |
| 169.9 } | 16.5 | 8 | 7.7 | 44 | 4.7 | 81 | 7.1 | 81 | 7.8 | 72 | 8.5 | 66 | C. C. |
| 170- } | 16.2 | 19 | 7.7 | 25 | 5.5 | 27 | 9.2 | 21 | 12.2 | 9 | 12.8 | 4 | N. A. |
| 174.9 } | 15.2 | 4 | 7.5 | 19 | 4.3 | 30 | 6.4 | 29 | 7.1 | 27 | 7.4 | 25 | C. C. |
| 175- } | 18.0 | 2 | 6.0 | 4 | 3.5 | 4 | 3.0 | 2 | 4.0 | 1 | 4.0 | 1 | N. A. |
| 179.9 } | 17.3 | 1 | 8.8 | 3 | 3.9 | 4 | 5.9 | 3 | 7.2 | 3 | 7.9 | 3 | C. C. |
| 180- } | | | 4.0 | 1 | 1.0 | 1 | 2.0 | 1 | 3.0 | 1 | 3.0 | 1 | N. A. |
| 184.9 } | 15.6 | 1 | 7.1 | 1 | 4.0 | 2 | 4.7 | 2 | 5.5 | 2 | 5.8 | 2 | C. C. |

Average—Newark Academy at 14 years—155.7 cm.
City College at 14 years—156.3 cm.

non-Hebrew girls, the same as in the averages of the total series. In the group, maximum rate 11-12, there is hardly any difference, while the difference in the group, maximum rate 10-11, is striking. Since the adults in this group show also considerable differences in stature, it may well be that this is due to the accidental composition of the series. The number of cases is too small to allow us to lay any stress on this anomaly (Table 7).

TABLE 7a

*Mean and Variability of Stature at Each Age for Those Having Their Maximum Rate of Growth at the Same Age Interval—Horace Mann Non-Hebrew Girls*

| TIME OF MAX. GROWTH | | AGE | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 9-10 years | M | 116.1 | 123.3 | 128.6 | 134.5 | 142.4 | 149.5 | 154.8 | 158.1 | 160.8 | 162.0 | 167.0 | 169.9 | .... | .... | .... |
| | σ | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| | f | 6 | 8 | 9 | 9 | 9 | 9 | 9 | 7 | 5 | 5 | 3 | 2 | .... | .... | .... |
| 10-11 | M | 116.7 | 122.9 | 128.6 | 134.1 | 140.3 | 148.4 | 155.0 | 159.0 | 161.2 | 162.2 | 162.7 | 163.1 | 164.0 | .... | .... |
| | σ | ±4.3 | ±4.0 | ±4.3 | ±5.0 | ±4.9 | ±4.8 | ±4.8 | ±4.8 | ±4.8 | ±4.7 | ±4.9 | ±5.2 | ±4.9 | .... | .... |
| | f | 17 | 28 | 34 | 44 | 44 | 44 | 44 | 41 | 35 | 29 | 26 | 22 | 11 | .... | .... |
| 11-12 | M | 115.5 | 121.7 | 127.5 | 132.2 | 137.7 | 143.8 | 151.3 | 157.0 | 160.2 | 161.5 | 162.4 | 163.3 | 162.4 | 163.2 | .... |
| | σ | ±4.2 | ±5.0 | ±5.1 | ±5.4 | ±5.6 | ±5.7 | ±6.0 | ±6.2 | ±6.2 | ±6.2 | ±6.4 | ±6.5 | ±6.0 | ±5.6 | .... |
| | f | 44 | 58 | 69 | 87 | 101 | 101 | 101 | 101 | 98 | 90 | 83 | 68 | 37 | 16 | .... |
| 12-13 | M | 115.2 | 120.3 | 125.5 | 131.4 | 136.3 | 141.4 | 147.2 | 154.3 | 159.4 | 161.9 | 163.0 | 163.5 | 163.5 | 164.0 | 165.8 |
| | σ | ±3.8 | ±4.0 | ±4.5 | ±4.9 | ±5.5 | ±5.6 | ±5.7 | ±5.9 | ±5.9 | ±5.8 | ±5.9 | ±5.9 | ±4.8 | ±5.3 | ±4.8 |
| | f | 23 | 42 | 55 | 63 | 78 | 86 | 86 | 86 | 86 | 84 | 77 | 66 | 37 | 17 | 11 |
| 13-14 | M | .... | 118.1 | 123.6 | 128.7 | 133.1 | 137.9 | 142.8 | 148.3 | 155.1 | 159.8 | 161.8 | 162.8 | 163.9 | 163.8 | .... |
| | σ | .... | ±4.2 | ±4.0 | ±4.1 | ±4.4 | ±4.7 | ±4.7 | ±4.8 | ±5.1 | ±5.2 | ±5.2 | ±5.4 | ±5.4 | ±5.5 | .... |
| | f | .... | 17 | 23 | 33 | 43 | 46 | 49 | 49 | 48 | 48 | 45 | 40 | 22 | 11 | .... |
| 14-15 | M | 113.5 | 117.9 | 120.2 | 124.6 | 129.2 | 132.9 | 137.2 | 142.5 | 148.0 | 154.4 | 158.4 | 157.7 | 158.7 | 159.2 | 159.9 |
| | σ | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| | f | 1 | 3 | 4 | 4 | 4 | 5 | 5 | 7 | 7 | 7 | 7 | 5 | 5 | 3 | 3 |
| 15-16 | M | .... | .... | .... | 132.7 | 137.3 | 140.4 | 143.2 | 147.6 | 152.7 | 157.5 | 162.7 | 165.7 | 167.6 | .... | .... |
| | σ | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| | f | .... | .... | .... | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | .... | .... |

TABLE 7b

*Mean and Variability of Stature at Each Age for Those Having Their Maximum Rate of Growth at the Same Age Interval—Horace Mann Hebrew Girls*

| TIME OF MAX. GROWTH | | AGE 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9-10 years | M | 117.8 | 122.9 | 128.3 | 134.0 | 141.3 | 147.7 | 153.6 | 158.2 | 160.8 | 162.9 | 164.7 | 165.3 | 155.1 | 155.5 | 155.9 |
| | σ | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| | f | 3 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 3 | 3 | 1 | 1 | 1 |
| 10-11 | M | .... | 119.1 | 124.6 | 130.3 | 135.9 | 143.7 | 150.0 | 153.7 | 156.1 | 157.3 | 158.3 | 158.7 | 159.9 | .... | .... |
| | σ | .... | ±5.2 | ±4.6 | ±4.6 | ±5.0 | ±5.3 | ±5.4 | ±5.1 | ±4.8 | ±4.7 | ±4.7 | ±5.1 | ±5.6 | .... | .... |
| | f | .... | 18 | 21 | 22 | 22 | 22 | 22 | 21 | 20 | 18 | 17 | 17 | 12 | .... | .... |
| 11-12 | M | 116.7 | 122.3 | 127.3 | 133.1 | 138.3 | 144.1 | 151.5 | 157.1 | 160.4 | 161.6 | 162.4 | 163.5 | 163.8 | .... | .... |
| | σ | ±4.8 | ±4.7 | ±4.8 | ±4.8 | ±5.2 | ±5.2 | ±5.7 | ±5.7 | ±5.6 | ±5.3 | ±5.5 | ±5.7 | ±5.4 | .... | .... |
| | f | 25 | 31 | 43 | 52 | 61 | 61 | 61 | 61 | 60 | 53 | 52 | 41 | 28 | .... | .... |
| 12-13 | M | 113.2 | 119.3 | 124.5 | 129.7 | 134.6 | 139.6 | 145.0 | 152.0 | 157.1 | 159.6 | 160.7 | 161.4 | 161.0 | 162.3 | .... |
| | σ | ±4.0 | ±4.8 | ±5.2 | ±6.3 | ±6.5 | ±6.6 | ±6.8 | ±7.0 | ±7.0 | ±6.9 | ±6.6 | ±6.7 | ±6.6 | ±6.2 | .... |
| | f | 16 | 35 | 44 | 55 | 62 | 63 | 63 | 63 | 63 | 61 | 60 | 48 | 37 | 24 | .... |
| 13-14 | M | .... | 117.4 | 123.0 | 128.3 | 133.2 | 137.7 | 142.6 | 148.2 | 154.7 | 159.2 | 161.2 | 162.4 | 162.9 | .... | .... |
| | σ | .... | ±4.1 | ±5.1 | ±6.0 | ±5.2 | ±5.1 | ±5.4 | ±5.6 | ±6.2 | ±6.1 | ±6.3 | ±6.2 | ±6.9 | .... | .... |
| | f | .... | 14 | 21 | 29 | 31 | 36 | 36 | 36 | 36 | 36 | 34 | 30 | 21 | .... | .... |
| 14-15 | M | .... | .... | .... | .... | .... | .... | 149.6 | 154.5 | 161.0 | 167.6 | 170.7 | 171.3 | 171.5 | .... | .... |
| | σ | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| | f | .... | .... | .... | .... | .... | .... | 1 | 1 | 1 | 1 | 1 | 1 | 1 | .... | .... |

I give here also the corresponding table for boys (Table 8).

STATURE AND TIME OF ADOLESCENCE

During the period of growth the average stature for a given year is the less, the later the maximum rate of growth.[4] The phenomenon just described has also been observed in the boys of Newark Academy and of City College* (Table 8). In both series the adult statures are not appreciably influenced by acceleration or retardation. This seems to be an important point, for it shows that acceleration is not a hereditary feature connected with different adult statures. This does not imply that there is no difference in the rapidity of growth according to individual genetic type, although it must be borne in mind that the differences of time of adolescence in different social strata prove that environmental conditions play a most important rôle in determining this period.

It is still an open question how far there may also be differences in period due to racial descent. In our material racial differences are evidently irrelevant.

I have also calculated the growth data according to the date of first menstruation (Table 9, Fig. 2). These tables agree with those for maximum rate of growth, except that allowance must be made for the difference in time, the first menstruation coming a little more than one year after the period of maximum growth. It will also be noted that the relation between stature and first menstruation is not as close as that between stature and period of most rapid growth. This is indicated by the incomplete agreement between the two. Maximum growth occurs between 10 and 11 years for those with first menstruation between 10 and 12; between 11 and 12 for those with first menstruation between 12 and 13 years; between 12 and 13 years for those with first menstruation between 13 and 17. This is corroborated by the more distinct maximum of variability which appears fairly clearly in Table 9, p. 323, while it is very weakly marked, when at all present, in Table 7, pp. 319 and 320.

[4] In this respect the Hebrew girls with maximum rate 10-11 make an exception (Table 7b). This corroborates our view that the composition of the series does not agree with the others.

* The "entire group" of City College includes those for whom the maximum rate of growth could not be ascertained on account of the shortness of the period of their stay in college.

TABLE 8

*Mean and Variability of Stature at Each Age for Those Having Their Maximum Rate of Growth at the Same Age Interval*

| TIME OF MAX. GROWTH | *Newark Academy* AGE 11 yrs. | 12 | 13 | 14 | 15 | 16 | 17 | 18 | Adult |
|---|---|---|---|---|---|---|---|---|---|
| 12-13 | 142.2±5.1<br>19 | 148.7±5.5<br>20 | 158.7±6.5<br>20 | 165.7±6.4<br>20 | 170.2±5.9<br>20 | ..... | ..... | ..... | (175.7) |
| 13-14 | 140.5±5.4<br>42 | 145.5±5.3<br>70 | 151.8±5.2<br>74 | 161.1±5.5<br>74 | 167.2±5.5<br>74 | 170.9±5.7<br>59 | 172.8±5.0<br>38 | 171.9±3.6<br>19 | 174.2±4.6 |
| 14-15 | 139.5±5.4<br>58 | 143.9±6.3<br>93 | 148.6±6.7<br>127 | 155.1±6.9<br>129 | 164.1±7.0<br>129 | 169.9±6.9<br>124 | 172.6±6.8<br>81 | 174.5±6.8<br>44 | 176.7±5.6 |
| 15-16 | 135.8±5.4<br>19 | 140.8±6.4<br>36 | 144.7±6.3<br>54 | 150.2±6.8<br>64 | 156.3±7.2<br>64 | 165.1±7.3<br>64 | 170.0±7.0<br>59 | 173.3±7.6<br>35 | 178.9±6.3 |
| 16-17 | ..... | ..... | ..... | 145.7±7.3<br>18 | 150.5±7.4<br>18 | 157.2±7.5<br>18 | 165.9±8.1<br>18 | 169.0±7.9<br>15 | (175.4) |
| Total of above cases | 139.7±5.7<br>138 | 144.3±6.3<br>219 | 149.4±7.2<br>275 | 155.7±8.3<br>305 | 162.8±8.4<br>305 | 168.1±7.7<br>265 | 171.2±7.0<br>196 | 173.6±6.7<br>98 | 176.1±5.9 |
| | *City College* AGE 12 yrs. | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 13-14 | 144.7±6.4<br>29 | 151.1±6.4<br>29 | 159.9±6.2<br>29 | 166.1±6.2<br>29 | 168.4±5.4<br>28 | 169.7±5.2<br>25 | 169.8±5.6<br>22 | 169.8±5.2<br>15 | ..... |
| 14-15 | 143.7±7.4<br>26 | 148.3±7.1<br>117 | 154.3±6.9<br>117 | 162.9±6.8<br>117 | 168.4±6.5<br>115 | 170.6±6.4<br>96 | 171.8±6.4<br>85 | 172.1±6.8<br>55 | 170.9±6.9<br>24 |
| 15-16 | ..... | 146.6±6.8<br>35 | 149.7±6.1<br>87 | 155.6±6.3<br>87 | 163.9±6.2<br>87 | 168.5±6.0<br>84 | 170.8±6.0<br>76 | 171.4±5.9<br>52 | 171.2±6.7<br>23 |
| 16-17 | ..... | ..... | 143.7±6.9<br>21 | 148.1±6.4<br>21 | 153.8±6.5<br>21 | 161.9±6.5<br>21 | 166.0±6.1<br>20 | 167.6±6.7<br>16 | ..... |
| Total entire group | 144.9±7.1<br>89 | 150.4±7.8<br>392 | 156.3±8.4<br>755 | 162.4±8.0<br>847 | 166.7±7.2<br>879 | 168.8±6.8<br>894 | 169.8±6.7<br>852 | 169.8±6.7<br>641 | 168.8±6.8<br>350 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ... | ... | 21 | 21 | 21 | 21 | 20 | 16 | ... | | |
| Total entire group | 144.9±7.1<br>89 | 150.4±7.8<br>392 | 156.3±8.4<br>755 | 162.4±8.0<br>847 | 166.7±7.2<br>879 | 168.8±6.8<br>894 | 169.8±6.7<br>852 | 169.8±6.7<br>641 | 168.8±6.8<br>350 | | |

TABLE 9

*Mean Stature at Each Age for Girls With Same Menstruation Date—Horace Mann Girls—Hebrew and Non-Hebrew*

| TIME OF FIRST MENS. | AGE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 yrs. | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 9 to 9-11 | ....<br>.... | .....<br>... | .....<br>... | 154.6<br>2 | 158.1<br>2 | 160.5<br>2 | 163.3<br>1 | 163.3<br>1 | 164.5<br>2 | 165.0<br>2 | 164.1<br>1 |
| 10 to 10-11 | 122.9<br>3 | 127.2±3.1<br>5 | 134.6±6.5<br>7 | 141.5±6.3<br>9 | 149.7±5.8<br>12 | 155.3±5.0<br>12 | 157.7±5.1<br>12 | 156.7<br>7 | 158.1<br>7 | 160.4<br>6 | 162.1<br>5 |
| 11 to 11-11 | 121.6<br>21 | 127.3±4.9<br>22 | 133.6±5.8<br>27 | 140.3±6.0<br>33 | 148.0±6.4<br>39 | 155.1±5.8<br>48 | 158.8±5.7<br>48 | 160.7±5.7<br>50 | 161.1±5.4<br>43 | 161.2±5.1<br>31 | 161.4±5.5<br>24 |
| 12 to 12-11 | 121.6<br>27 | 127.1±5.4<br>38 | 132.7±5.4<br>45 | 138.6±5.4<br>54 | 144.6±5.6<br>67 | 151.3±6.1<br>86 | 156.8±5.7<br>110 | 159.5±5.7<br>121 | 160.2±5.8<br>127 | 160.6±6.2<br>108 | 161.4±5.7<br>74 |
| 13 to 13-11 | 120.9<br>38 | 126.9±4.3<br>43 | 132.5±4.4<br>48 | 137.6±4.8<br>50 | 142.6±5.3<br>58 | 149.0±5.8<br>74 | 156.1±5.7<br>104 | 160.0±5.7<br>134 | 161.0±6.1<br>143 | 161.1±6.5<br>128 | 161.4±6.7<br>111 |
| 14 to 14-11 | 120.2<br>14 | 124.8±6.4<br>18 | 130.4±6.8<br>19 | 134.7±7.3<br>18 | 139.8±7.1<br>19 | 144.4±6.6<br>21 | 150.9±7.5<br>27 | 156.6±6.2<br>44 | 159.5±5.7<br>58 | 161.3±6.0<br>69 | 162.3±6.3<br>68 |
| 15 to 15-11 | 118.9<br>4 | 123.7<br>5 | 129.5<br>7 | 132.5<br>9 | 137.3<br>9 | 142.2±4.6<br>10 | 149.7±8.0<br>13 | 154.0±10.2<br>15 | 157.7±9.0<br>20 | 160.1±8.2<br>27 | 158.8±7.6<br>23 |
| 16 to 16-11 | 119.7<br>2 | 120.9<br>3 | 126.1<br>3 | 131.9<br>3 | 136.7<br>3 | 141.7<br>3 | 148.4<br>3 | 152.3<br>3 | 157.3<br>3 | 159.0<br>4 | 157.7<br>6 |

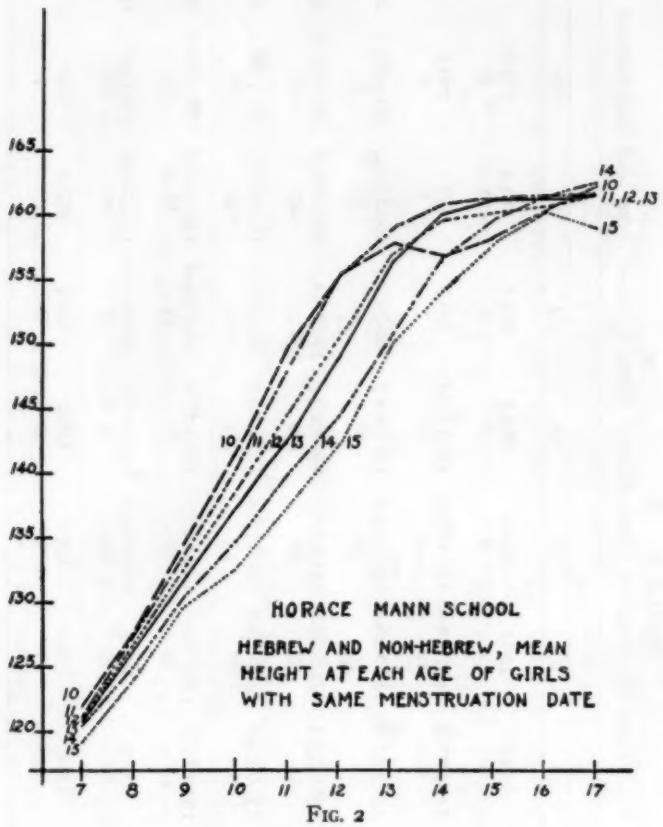


FIG. 2

VARIABILITY

In Table 10 the amounts of the maximum variability and their excesses over the variabilities of adjoining years are given for the total series and for the series classified according to period of adolescence: 1. for Horace Mann School non-Hebrew girls totals; 2. for Horace Mann School Hebrew girls totals; 3. for Horace Mann School non-Hebrew girls according to period of maximum rate of growth; 4. for Horace Mann School Hebrew girls according to maximum rate of growth; 5. for Horace Mann School girls according to date of first menstruation; 6. for Newark Academy boys totals; 7. for City College boys totals; 8. for Newark Academy boys according to period of maximum rate of growth; 9. for City College boys according to period of maximum rate of growth.

TABLE 10

*Maximum Variabilities and Their Excesses Over the Variabilities of Adjoining Years*

TABLE 10

*Maximum Variabilities and Their Excesses Over the Variabilities of Adjoining Years*

| | AGE OF MAX. RATE | —6 yrs. | —5 yrs. | —4 yrs. | —3 yrs. | —2 yrs. | —1 yr. | Max. | +1 yr. | +2 yrs. | +3 yrs. | +4 yrs. | +5 yrs. | +6 yrs. | +7 yrs. | +8 yrs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | *1 and 2. Horace Mann School Girls Totals* | | | | | | | | | |
| 1. | 12 | —2.6 | —2.3 | —1.9 | —1.6 | —1.0 | — .4 | 7.0 | — .3 | — .8 | —1.2 | —1.1 | —1.0 | —1.2 | —1.8 | —1.9 |
| 2. | 12 | —3.6 | —2.3 | —2.2 | —1.3 | —1.1 | — .7 | 7.3 | — .3 | —1.0 | —1.2 | —1.1 | —1.0 | — .8 | —1.2 | —1.6 |
| | | | | | | | *3 and 4. Horace Mann School Girls According to Period of Maximum Rate of Growth* | | | | | | | | | |
| 3. | 9(10-11) | .... | .... | .... | — .7 | —1.0 | — .7 | 5.0 | — .1 | — .2 | — .2 | — .2 | — .2 | — .3 | — .1 | .... |
| | 11-12 | | | | | | | | | | | | | | | |
| | 12-13 | no maximum during growth | | | | | | | | | | | | | | |
| | 13-14 | | | | | | | | | | | | | | | |
| 4. | 12(10-11) | .... | — .2 | — .8 | — .8 | — .4 | — .1 | 5.4 | — .3 | — .6 | — .7 | — .7 | — .3 | + .2 | .... | .... |
| | 13(11-12) | — .8 | — .7 | — .7 | — .5 | — .5 | 00 | 5.7 | — .1 | — .3 | — .2 | .0 | — .3 | .... | .... | .... |
| | 14(12-13) | — .8 | — .7 | — .5 | — .4 | — .2 | 00 | 7.0 | — .1 | — .4 | — .3 | — .4 | — .8 | .... | .... | .... |
| | 13-14 | no maximum during growth | | | | | | | | | | | | | | |
| | | | | | | | *5. Horace Mann School Girls According to Time of First Menstruation* | | | | | | | | | |
| 5. | 11(11-12) | .... | .... | .... | —1.5 | — .6 | — .4 | 6.4 | — .6 | — .7 | — .7 | —1.0 | —1.3 | — .9 | .... | .... |
| | 12(12-13) | .... | .... | — .7 | — .7 | — .7 | — .5 | 6.1 | — .4 | — .4 | — .3 | + .1 | — .4 | .... | .... | .... |
| | 13-14 | no maximum during growth | | | | | | | | | | | | | | |
| | 13(14-15) | .... | .... | — .7 | — .2 | — .4 | — .9 | 7.5 | —1.3 | —1.8 | —1.5 | —1.2 | .... | .... | .... | .... |
| | 14(15-16) | .... | .... | .... | .... | .... | —2.2 | 10.2 | —1.2 | —2.0 | —2.6 | .... | .... | .... | .... | .... |
| | | | | | | | *6 and 7. Newark Academy and City College Boys Totals* | | | | | | | | | |
| 6. | 15 | .... | .... | —2.7 | —2.1 | —1.2 | — .1 | 8.4 | — .7 | —1.4 | —1.7 | .... | .... | .... | .... | .... |
| 7. | 14 | .... | .... | .... | .... | —1.3 | — .6 | 8.4 | — .4 | —1.2 | —1.6 | —1.7 | —1.7 | .... | .... | .... |
| | | | | | | | *8 and 9. Newark Academy and City College Boys According to Period of Maximum Rate of Growth* | | | | | | | | | |
| 8. | 13(12-13) | .... | .... | .... | .... | —0.9 | —1.0 | 6.5 | — .1 | — .6 | .... | .... | .... | .... | .... | .... |
| | 13-14 | no clear maximum during growth | | | | | | | | | | | | | | |
| | 15(14-15) | .... | .... | —1.6 | — .7 | — .3 | — .1 | 7.0 | — .1 | — .2 | — .2 | .... | .... | .... | —1.4 | adult |
| | 16(15-16) | .... | .... | — .9 | —1.0 | — .5 | — .1 | 7.3 | — .3 | + .3 | .... | .... | .... | .... | —1.0 | adult |
| | 17(16-17) | .... | .... | .... | — .8 | — .7 | — .6 | 8.1 | — .2 | .... | .... | .... | .... | .... | .... | .... |
| 9. | 13(13-14) | .... | .... | .... | .... | .... | .0 | 6.4 | — .2 | — .2 | — .8 | —1.0 | — .6 | —1.0 | .... | .... |
| | 14-15 | | | | | | | | | | | | | | | |
| | 15-16 | no maximum during growth | | | | | | | | | | | | | | |
| | 16-17 | | | | | | | | | | | | | | | |

Considering that on account of the inaccuracy of measurements the period of maximum growth is not exactly determined, it seems plausible that if the classifications were made more rigidly the ill defined maxima would disappear entirely. The reduction in variability and the weakening of the maximum prove again that the great increase in variability of the total series at the period of adolescence is solely an effect of the retardation and acceleration of different individuals, for during the period of rapid growth those who are retarded will be much shorter than those who are accelerated.[5]

## GROWTH INCREMENTS

The detailed distributions of amounts of growth in the years preceding and following the period of maximum growth are given in Table 11. In Table 12, the same data are given for the years preceding and

TABLE 11a

*Individual Increments for Horace Mann Girls with Maximum Rate of Growth at Same Age*

| | AGE INTERVAL | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Maximum 10-11 Years* | | | | | | | | | | | | |
| INCREMENT | 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 |
| 0- 0.9 | .. | .. | .. | .. | .. | .. | .. | 1 | 19 | 32 | 35 | 18 | 9 |
| 1- 1.9 | 1 | .. | .. | .. | .. | .. | .. | 16 | 21 | 10 | 3 | 5 | 1 |
| 2- 2.9 | 0 | .. | .. | 1 | .. | .. | 11 | 26 | 3 | 1 | 1 | .. | .. |
| 3- 3.9 | 0 | .. | 1 | 0 | .. | .. | 17 | 6 | 2 | .. | .. | .. | .. |
| 4- 4.9 | 3 | 9 | 12 | 5 | .. | 4 | 17 | 2 | 1 | .. | .. | .. | .. |
| 5- 5.9 | 8 | 17 | 25 | 25 | 2 | 15 | 12 | 4 | .. | .. | .. | .. | .. |
| 6- 6.9 | 10 | 15 | 15 | 22 | 10 | 23 | 4 | .. | .. | .. | .. | .. | .. |
| 7- 7.9 | 3 | 4 | 2 | 10 | 18 | 21 | 1 | .. | .. | .. | .. | .. | .. |
| 8- 8.9 | .. | 0 | .. | 3 | 28 | 3 | .. | .. | .. | .. | .. | .. | .. |
| 9- 9.9 | .. | 0 | .. | .. | 5 | .. | .. | .. | .. | .. | .. | .. | .. |
| 10-10.9 | .. | 0 | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. |
| 11-11.9 | .. | 1 | .. | .. | 2 | .. | .. | .. | .. | .. | .. | .. | .. |

[5] Recently the same question has been discussed by Dahlberg in his observations on correlations of stature during the period of growth. It also agrees with observations on the development of girls with premature first menstruation. Gunnar Dahlberg. Korrelationserscheinungen bei nicht erwachsenen Individuen, etc. *Zeitschrift für Morphologie und Anthropologie*, 29 (1931): 288 *et seq.*, particularly p. 302.

*Maximum 11-12 Years*

| | 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0- 0.9 | .. | .. | .. | .. | 1 | .. | 1 | 2 | 24 | 79 | 98 | 60 | 33 |
| 1- 1.9 | .. | .. | 1 | .. | 0 | .. | 0 | 15 | 76 | 42 | 8 | 5 | .. |
| 2- 2.9 | .. | 1 | 0 | .. | 0 | .. | 3 | 51 | 28 | 3 | 2 | .. | .. |
| 3- 3.9 | 2 | 0 | 3 | 7 | 3 | .. | 7 | 44 | 9 | 1 | .. | .. | .. |
| 4- 4.9 | 1 | 17 | 29 | 34 | 20 | .. | 25 | 28 | 5 | .. | .. | .. | .. |
| 5- 5.9 | 16 | 32 | 46 | 68 | 48 | 4 | 53 | 15 | 2 | .. | .. | .. | .. |
| 6- 6.9 | 41 | 34 | 30 | 28 | 65 | 44 | 48 | 2 | .. | .. | .. | .. | .. |
| 7- 7.9 | 8 | 4 | 3 | 2 | 21 | 74 | 23 | 1 | .. | .. | .. | .. | .. |
| 8- 8.9 | 0 | 1 | .. | .. | 4 | 29 | 2 | .. | .. | .. | .. | .. | .. |
| 9- 9.9 | 0 | .. | .. | .. | .. | 11 | .. | .. | .. | .. | .. | .. | .. |
| ..... | ..... | | | | | | | | | | | | |
| 11-11.9 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |

*Maximum 12-13 Years*

| | 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0- 0.9 | .. | .. | .. | .. | .. | .. | .. | .. | 5 | 51 | 85 | 68 | 36 |
| 1- 1.9 | .. | .. | .. | .. | .. | 1 | .. | .. | 43 | 69 | 25 | 5 | 5 |
| 2- 2.9 | .. | .. | .. | .. | 1 | 1 | .. | 1 | 48 | 12 | 4 | 1 | .. |
| 3- 3.9 | 1 | 1 | 1 | 6 | 12 | 5 | .. | 28 | 30 | 3 | .. | .. | .. |
| 4- 4.9 | 5 | 12 | 22 | 46 | 51 | 24 | 1 | 44 | 17 | 2 | .. | .. | .. |
| 5- 5.9 | 16 | 38 | 53 | 54 | 57 | 60 | 14 | 42 | 3 | .. | .. | .. | .. |
| 6- 6.9 | 12 | 21 | 19 | 10 | 16 | 46 | 53 | 26 | .. | .. | .. | .. | .. |
| 7- 7.9 | 5 | 6 | 4 | 2 | 4 | 13 | 63 | 7 | .. | .. | .. | .. | .. |
| 8- 8.9 | 1 | .. | 1 | 1 | .. | .. | 13 | 2 | .. | .. | .. | .. | .. |
| 9- 9.9 | .. | .. | .. | .. | .. | .. | 4 | .. | .. | .. | .. | .. | .. |
| 10-10.9 | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. |
| ..... | | | | | | | ..... | | | | | | |
| 12-12.9 | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. |

*Maximum 13-14 Years*

| | 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0- 0.9 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 | 35 | 39 | 18 |
| 1- 1.9 | .. | .. | .. | .. | .. | .. | .. | .. | 3 | 33 | 29 | 4 | 3 |
| 2- 2.9 | .. | .. | 1 | .. | .. | 2 | .. | .. | 2 | 29 | 5 | .. | .. |
| 3- 3.9 | .. | .. | 3 | 8 | 3 | 10 | 3 | .. | 19 | 11 | 1 | .. | .. |
| 4- 4.9 | 3 | 8 | 13 | 24 | 31 | 31 | 19 | 1 | 26 | 3 | .. | .. | .. |
| 5- 5.9 | 11 | 18 | 21 | 24 | 28 | 31 | 34 | 20 | 29 | .. | .. | .. | .. |
| 6- 6.9 | 1 | 4 | 6 | 3 | 7 | 7 | 25 | 35 | 4 | .. | .. | .. | .. |
| 7- 7.9 | .. | .. | .. | .. | 1 | .. | 3 | 23 | 1 | .. | .. | .. | .. |
| 8- 8.9 | .. | .. | .. | .. | .. | .. | .. | 3 | .. | .. | .. | .. | .. |
| ..... | | | | | | | | ..... | | | | | |
| 10-10.9 | .. | .. | .. | .. | .. | .. | .. | 2 | .. | .. | .. | .. | .. |

TABLE 11b

*Individual Increments for Newark Academy Boys With Maximum Rate of Growth at Same Age*

| INCREMENT | *Maximum Growth 12-13* AGE INTERVAL | | | | | | |
|---|---|---|---|---|---|---|---|
| | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 |
| 0- 0.9 | .. | 1 | .. | .. | .. | 4 | 2 |
| 1- 1.9 | .. | 0 | .. | .. | .. | 5 | 2 |
| 2- 2.9 | 1 | 0 | .. | .. | 5 | 2 | .. |
| 3- 3.9 | 1 | 1 | .. | .. | 5 | 2 | .. |
| 4- 4.9 | 1 | 2 | .. | 2 | 4 | .. | .. |
| 5- 5.9 | 1 | 4 | .. | 3 | 1 | .. | .. |
| 6- 6.9 | 2 | 4 | 1 | 4 | 4 | .. | .. |
| 7- 7.9 | .. | 4 | 1 | 4 | 1 | .. | .. |
| 8- 8.9 | .. | 2 | 3 | 4 | .. | .. | .. |
| 9- 9.9 | .. | 1 | 6 | 3 | .. | .. | .. |
| 10-10.9 | .. | .. | 4 | .. | .. | .. | .. |
| 11-11.9 | .. | .. | 2 | .. | .. | .. | .. |
| 12-12.9 | .. | .. | 1 | .. | .. | .. | .. |
| 13-13.9 | .. | .. | 2 | .. | .. | .. | .. |

| INCREMENT | *Maximum Growth 13-14* AGE INTERVAL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 |
| 0- 0.9 | .. | .. | .. | .. | .. | 3 | 11 | 12 |
| 1- 1.9 | .. | .. | .. | .. | .. | 4 | 11 | 6 |
| 2- 2.9 | .. | .. | .. | .. | 4 | 17 | 8 | 0 |
| 3- 3.9 | 1 | 6 | 4 | .. | 2 | 20 | 4 | 1 |
| 4- 4.9 | 10 | 17 | 10 | .. | 9 | 9 | 1 | .. |
| 5- 5.9 | 7 | 12 | 11 | 3 | 18 | 3 | 2 | .. |
| 6- 6.9 | 0 | 5 | 20 | 3 | 18 | 2 | .. | .. |
| 7- 7.9 | 1 | 1 | 17 | 8 | 11 | 0 | .. | .. |
| 8- 8.9 | .. | 0 | 5 | 11 | 8 | 1 | .. | .. |
| 9- 9.9 | .. | 0 | 2 | 26 | 4 | .. | .. | .. |
| 10-10.9 | .. | 1 | 1 | 13 | .. | .. | .. | .. |
| 11-11.9 | .. | .. | .. | 5 | .. | .. | .. | .. |
| 12-12.9 | .. | .. | .. | 5 | .. | .. | .. | .. |

| INCREMENT | *Maximum Growth 14-15* AGE INTERVAL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 |
| 0- 0.9 | .. | .. | 1 | 1 | .. | 1 | 5 | 11 |
| 1- 1.9 | .. | 1 | 0 | 1 | .. | 2 | 11 | 14 |
| 2- 2.9 | .. | 1 | 1 | 0 | .. | 4 | 25 | 15 |
| 3- 3.9 | 4 | 12 | 17 | 2 | .. | 6 | 21 | 4 |
| 4- 4.9 | 8 | 27 | 29 | 13 | .. | 18 | 14 | .. |
| 5- 5.9 | 7 | 14 | 31 | 22 | 1 | 28 | 2 | .. |
| 6- 6.9 | 1 | 3 | 11 | 36 | 2 | 34 | 2 | .. |
| 7- 7.9 | .. | .. | 2 | 29 | 15 | 17 | 1 | .. |
| 8- 8.9 | .. | .. | 1 | 16 | 42 | 13 | .. | .. |
| 9- 9.9 | .. | .. | .. | 5 | 39 | 1 | .. | .. |
| 10-10.9 | .. | .. | .. | 1 | 18 | .. | .. | .. |
| 11-11.9 | .. | .. | .. | 1 | 7 | .. | .. | .. |
| 12-12.9 | .. | .. | .. | .. | 4 | .. | .. | .. |
| 13-13.9 | .. | .. | .. | .. | 1 | .. | .. | .. |

*Maximum Growth 15-16*

| INCREMENT | AGE INTERVAL | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 |
| 0- 0.9 | .. | .. | .. | .. | .. | .. | .. | 3 | 5 |
| 1- 1.9 | .. | .. | 1 | .. | .. | .. | 2 | 7 | 2 |
| 2- 2.9 | .. | 1 | 2 | 3 | .. | .. | 1 | 11 | 3 |
| 3- 3.9 | 2 | 4 | 9 | 5 | 1 | .. | 3 | 8 | 1 |
| 4- 4.9 | 3 | 9 | 19 | 28 | 15 | .. | 13 | 3 | .. |
| 5- 5.9 | 2 | 4 | 4 | 10 | 12 | .. | 17 | 3 | .. |
| 6- 6.9 | .. | 1 | 1 | 7 | 16 | 5 | 11 | .. | .. |
| 7- 7.9 | .. | .. | .. | 1 | 14 | 11 | 10 | .. | .. |
| 8- 8.9 | .. | .. | .. | .. | 5 | 18 | 1 | .. | .. |
| 9- 9.9 | .. | .. | .. | .. | 1 | 18 | 1 | .. | .. |
| 10-10.9 | .. | .. | .. | .. | .. | 12 | .. | .. | .. |

*Maximum Growth 16-17*

| INCREMENT | AGE INTERVAL | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 |
| 0- 0.9 | .. | .. | .. | .. | .. | .. | .. | 1 | .. |
| 1- 1.9 | .. | .. | .. | .. | .. | .. | .. | 0 | 1 |
| 2- 2.9 | .. | .. | .. | .. | .. | .. | .. | 2 | 2 |
| 3- 3.9 | .. | .. | 1 | 4 | 3 | 1 | .. | 1 | 0 |
| 4- 4.9 | 2 | 4 | 4 | 6 | 8 | 1 | .. | 4 | 0 |
| 5- 5.9 | 1 | .. | .. | 0 | 5 | 1 | .. | 4 | 1 |
| 6- 6.9 | .. | .. | .. | 1 | 1 | 7 | 1 | 1 | .. |
| 7- 7.9 | .. | .. | .. | .. | 1 | 4 | 5 | 2 | .. |
| 8- 8.9 | .. | .. | .. | .. | .. | 3 | 4 | .. | .. |
| 9- 9.9 | .. | .. | .. | .. | .. | 1 | 6 | .. | .. |
| 10-10.9 | .. | .. | .. | .. | .. | .. | 1 | .. | .. |
| 11-11.9 | .. | .. | .. | .. | .. | .. | 1 | .. | .. |

## TABLE 11c

*Individual Increments for City College Boys with Maximum Rate of Growth at Same Age*

*Maximum Rate of Growth 13-14*

| INCREMENT | AGE INTERVAL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 | 19-20 |
| 0- 0.9 | .. | .. | .. | 2 | 6 | 18 | 11 | 4 |
| 1- 1.9 | .. | .. | .. | 5 | 14 | 4 | 4 | .. |
| 2- 2.9 | 1 | .. | 1 | 5 | 4 | .. | .. | .. |
| 3- 3.9 | 0 | .. | 3 | 11 | 1 | .. | .. | .. |
| 4- 4.9 | 6 | .. | 3 | 4 | .. | .. | .. | .. |
| 5- 5.9 | 3 | .. | 5 | 0 | .. | .. | .. | .. |
| 6- 6.9 | 9 | .. | 8 | 1 | .. | .. | .. | .. |
| 7- 7.9 | 6 | 8 | 7 | .. | .. | .. | .. | .. |
| 8- 8.9 | 3 | 10 | 1 | .. | .. | .. | .. | .. |
| 9- 9.9 | 1 | 5 | 0 | .. | .. | .. | .. | .. |
| 10-10.9 | .. | 4 | 1 | .. | .. | .. | .. | .. |
| 11-11.9 | .. | 2 | .. | .. | .. | .. | .. | .. |
| 12-12.9 | .. | .. | .. | .. | .. | .. | .. | .. |

*Maximum Rate of Growth 14-15*

| INCREMENT | AGE INTERVAL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 | 19-20 |
| 0- 0.9 | .. | .. | .. | .. | 5 | 43 | 44 | 20 |
| 1- 1.9 | 2 | 1 | .. | 2 | 25 | 34 | 10 | 4 |
| 2- 2.9 | 0 | 5 | .. | 6 | 33 | 8 | 1 | .. |
| 3- 3.9 | 7 | 3 | .. | 12 | 23 | .. | .. | .. |
| 4- 4.9 | 7 | 14 | .. | 16 | 7 | .. | .. | .. |
| 5- 5.9 | 6 | 36 | .. | 25 | 2 | .. | .. | .. |
| 6- 6.9 | 3 | 26 | 10 | 34 | 1 | .. | .. | .. |
| 7- 7.9 | 1 | 18 | 23 | 15 | .. | .. | .. | .. |
| 8- 8.9 | .. | 13 | 38 | 5 | .. | .. | .. | .. |
| 9- 9.9 | .. | 1 | 30 | .. | .. | .. | .. | .. |
| 10-10.9 | .. | .. | 9 | .. | .. | .. | .. | .. |
| 11-11.9 | .. | .. | 3 | .. | .. | .. | .. | .. |
| 12-12.9 | .. | .. | 4 | .. | .. | .. | .. | .. |

*Maximum Rate of Growth 15-16*

| INCREMENT | AGE INTERVAL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 | 19-20 |
| 0- 0.9 | .. | .. | .. | .. | .. | 5 | 20 | 20 |
| 1- 1.9 | .. | .. | .. | .. | 2 | 27 | 27 | 4 |
| 2- 2.9 | 1 | 3 | 2 | .. | 5 | 34 | 4 | .. |
| 3- 3.9 | 2 | 8 | 3 | .. | 16 | 7 | 1 | .. |
| 4- 4.9 | .. | 16 | 19 | .. | 23 | 2 | 0 | .. |
| 5- 5.9 | .. | 3 | 19 | 3 | 25 | 2 | 0 | .. |
| 6- 6.9 | .. | 4 | 27 | 14 | 7 | .. | 0 | .. |
| 7- 7.9 | .. | 2 | 15 | 19 | 7 | .. | 1 | .. |
| 8- 8.9 | .. | .. | 2 | 27 | .. | .. | .. | .. |
| 9- 9.9 | .. | .. | 1 | 17 | .. | .. | .. | .. |
| 10-10.9 | .. | .. | .. | 6 | .. | .. | .. | .. |
| 11-11.9 | .. | .. | .. | 2 | .. | .. | .. | .. |
| 12-12.9 | .. | .. | .. | .. | .. | .. | .. | .. |

*Maximum Rate of Growth 16-17*

| INCREMENT | AGE INTERVAL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 | 19-20 |
| 0- 0.9 | .. | 1 | .. | .. | .. | 1 | 3 | 6 |
| 1- 1.9 | .. | 0 | .. | .. | .. | 1 | 6 | 3 |
| 2- 2.9 | 1 | 1 | 2 | .. | .. | 1 | 4 | 1 |
| 3- 3.9 | 3 | 4 | 5 | 3 | .. | 5 | 3 | .. |
| 4- 4.9 | .. | 2 | 6 | 3 | .. | 5 | .. | .. |
| 5- 5.9 | .. | 1 | 4 | 5 | .. | 4 | .. | .. |
| 6- 6.9 | .. | .. | 4 | 5 | 5 | 1 | .. | .. |
| 7- 7.9 | .. | .. | .. | 5 | 2 | 2 | .. | .. |
| 8- 8.9 | .. | .. | .. | .. | 11 | .. | .. | .. |
| 9- 9.9 | .. | .. | .. | .. | 3 | .. | .. | .. |
| 10-10.9 | .. | .. | .. | .. | .. | .. | .. | .. |
| 11-11.9 | .. | .. | .. | .. | .. | .. | .. | .. |
| 12-12.9 | .. | .. | .. | .. | .. | .. | .. | .. |

## TABLE 12

*Individual Increments of Stature for Horace Mann Girls With Same Menstruation Date*

*Menstruation at 10 Years—10-11*

| INCREMENT | AGE INTERVAL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 |
| 0- 0.9 | .. | .. | .. | 1 | .. | 1 | 3 | 4 | 6 | 6 | 4 |
| 1- 1.9 | .. | .. | .. | 0 | .. | 3 | 2 | 2 | .. | .. | .. |
| 2- 2.9 | .. | .. | .. | 0 | 2 | 4 | 1 | .. | .. | .. | .. |
| 3- 3.9 | .. | .. | .. | 0 | 1 | 1 | .. | .. | .. | .. | .. |
| 4- 4.9 | .. | .. | .. | 0 | 0 | 1 | .. | .. | .. | .. | .. |
| 5- 5.9 | .. | 4 | 1 | 0 | 4 | 0 | .. | .. | .. | .. | .. |
| 6- 6.9 | 3 | 1 | 3 | 1 | 1 | 0 | .. | .. | .. | .. | .. |
| 7- 7.9 | 1 | .. | 2 | 3 | 3 | 1 | .. | .. | .. | .. | .. |
| 8- 8.9 | .. | .. | 1 | 3 | 1 | .. | .. | .. | .. | .. | .. |
| ..... | | | | ..... | | | | | | | |
| 11-11.9 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. |

*Menstruation at 11 Years*

| INCREMENT | AGE INTERVAL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 |
| 0- 0.9 | .. | .. | .. | .. | .. | 1 | 5 | 19 | 25 | 20 | 16 |
| 1- 1.9 | .. | .. | .. | .. | .. | 2 | 9 | 15 | 6 | 2 | .. |
| 2- 2.9 | .. | .. | .. | .. | 1 | 10 | 20 | 2 | .. | 1 | .. |
| 3- 3.9 | .. | .. | .. | .. | 1 | 11 | 2 | 1 | .. | .. | .. |
| 4- 4.9 | 2 | 2 | 3 | 1 | 1 | 9 | 1 | .. | .. | .. | .. |
| 5- 5.9 | 7 | 8 | 6 | 3 | 7 | 7 | 1 | .. | .. | .. | .. |
| 6- 6.9 | 10 | 10 | 8 | 3 | 9 | 2 | .. | .. | .. | .. | .. |
| 7- 7.9 | 2 | 1 | 6 | 10 | 12 | 1 | .. | .. | .. | .. | .. |
| 8- 8.9 | .. | 1 | 4 | 13 | 4 | .. | .. | .. | .. | .. | .. |
| 9- 9.9 | .. | .. | .. | 3 | 3 | .. | .. | .. | .. | .. | .. |
| ..... | | | | | ..... | | | | | | |
| 11-11.9 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. |

*Menstruation at 12 Years*

| INCREMENT | AGE INTERVAL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 |
| 0- 0.9 | .. | .. | .. | .. | .. | .. | 6 | 34 | 72 | 64 | 31 |
| 1- 1.9 | .. | 2 | .. | .. | .. | .. | 21 | 48 | 27 | 6 | 1 |
| 2- 2.9 | .. | 0 | .. | .. | .. | 4 | 34 | 12 | 2 | .. | .. |
| 3- 3.9 | .. | 0 | 2 | 2 | 1 | 10 | 24 | 6 | .. | .. | .. |
| 4- 4.9 | 8 | 9 | 7 | 4 | 1 | 15 | 12 | .. | .. | .. | .. |
| 5- 5.9 | 8 | 13 | 19 | 15 | 9 | 21 | 2 | .. | .. | .. | .. |
| 6- 6.9 | 11 | 11 | 15 | 18 | 13 | 20 | 2 | .. | .. | .. | .. |
| 7- 7.9 | 1 | 3 | 1 | 6 | 30 | 9 | 1 | .. | .. | .. | .. |
| 8- 8.9 | .. | .. | 0 | 7 | 12 | 2 | .. | .. | .. | .. | .. |
| 9- 9.9 | .. | .. | 0 | 0 | 1 | 1 | .. | .. | .. | .. | .. |
| 10-10.9 | .. | .. | 1 | 1 | .. | 1 | .. | .. | .. | .. | .. |
| 11-11.9 | .. | .. | .. | 1 | .. | 0 | .. | .. | .. | .. | .. |
| ..... | | | | | | ..... | | | | | |
| 16-16.9 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. |

*Menstruation at 13 Years*

| INCREMENT | AGE INTERVAL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 |
| 0- 0.9 | .. | .. | .. | .. | .. | .. | 2 | 15 | 51 | 76 | 48 |
| 1- 1.9 | .. | .. | .. | .. | .. | .. | 6 | 26 | 33 | 14 | 8 |
| 2- 2.9 | .. | .. | .. | .. | .. | 2 | 9 | 31 | 9 | 2 | .. |
| 3- 3.9 | .. | .. | .. | 1 | 1 | 2 | 17 | 13 | 1 | .. | .. |
| 4- 4.9 | .. | 1 | 4 | 7 | 0 | 2 | 12 | 4 | .. | .. | .. |
| 5- 5.9 | 8 | 14 | 16 | 10 | 10 | 10 | 11 | .. | .. | .. | .. |
| 6- 6.9 | 8 | 5 | 1 | 4 | 9 | 9 | 6 | .. | .. | .. | .. |
| 7- 7.9 | 1 | .. | 1 | 2 | 7 | 12 | 5 | .. | .. | .. | .. |
| 8- 8.9 | .. | .. | .. | .. | .. | 3 | 0 | .. | .. | .. | .. |
| ..... | | | | | | | ..... | | | | |
| 10-10.9 | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. |

*Menstruation at 14 Years*

| INCREMENT | AGE INTERVAL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 |
| 0- 0.9 | .. | .. | .. | .. | .. | .. | .. | 2 | 7 | 35 | 31 |
| 1- 1.9 | .. | .. | .. | .. | .. | .. | .. | 4 | 19 | 21 | 4 |
| 2- 2.9 | .. | .. | .. | .. | .. | .. | 2 | 8 | 21 | 2 | 2 |
| 3- 3.9 | .. | 1 | 3 | 2 | 1 | 1 | 0 | 10 | 3 | 1 | .. |
| 4- 4.9 | 3 | 5 | 8 | 6 | 7 | 3 | 4 | 11 | 0 | .. | .. |
| 5- 5.9 | 6 | 8 | 5 | 9 | 3 | 5 | 7 | 5 | 1 | .. | .. |
| 6- 6.9 | 5 | 4 | 2 | 1 | 7 | 7 | 8 | 1 | .. | .. | .. |
| 7- 7.9 | .. | .. | .. | .. | 1 | 5 | 4 | 1 | .. | .. | .. |
| 8- 8.9 | .. | .. | .. | .. | .. | .. | 2 | .. | .. | .. | .. |

*Menstruation at 15 Years*

| INCREMENT | AGE INTERVAL | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 |
| 0- 0.9 | .. | .. | .. | .. | .. | .. | 1 | 4 | 8 | 16 | 12 |
| 1- 1.9 | .. | .. | .. | .. | .. | .. | 2 | 9 | 12 | 9 | 5 |
| 2- 2.9 | .. | .. | 1 | .. | .. | .. | 2 | 9 | 8 | 3 | 1 |
| 3- 3.9 | .. | .. | 3 | 3 | 1 | .. | 5 | 4 | 2 | .. | .. |
| 4- 4.9 | 3 | 6 | 10 | 7 | 8 | 4 | 12 | 5 | 2 | .. | .. |
| 5- 5.9 | 13 | 18 | 15 | 14 | 9 | 13 | 11 | 6 | 1 | .. | .. |
| 6- 6.9 | 7 | 3 | 1 | 9 | 9 | 14 | 9 | 1 | .. | .. | .. |
| 7- 7.9 | 2 | 1 | 2 | 1 | 8 | 8 | 4 | .. | .. | .. | .. |
| 8- 8.9 | .. | .. | .. | 1 | 5 | 3 | 0 | .. | .. | .. | .. |
| 9- 9.9 | .. | .. | .. | .. | .. | 1 | 0 | .. | .. | .. | .. |
| ..... | | | | | | ..... | | | | | |
| 13-13.9 | .. | .. | .. | .. | .. | 1 | 1 | .. | .. | .. | .. |

following the date of first menstruation. I have not tried to correlate the increment at the time of maximum rate of growth with the later increments, because the values, on account of the observational errors, are too uncertain. For the same reason I have not determined the variabilities of the increments, which seem to range about ±1.0 cm. The

tables show again that the span of continued growth varies considerably among individuals who have the same period of maximum rate of growth. It would be of great interest to study those individuals who have the same period of maximum growth and the same total period of growth. This cannot be done adequately with the material at my disposal.

A most important point appears through a study of the distribution of the amounts of growth in the years preceding and following the

TABLE 13

*Total Increment in Stature During Various Intervals Around the Period of Maximum Growth*

*a. Horace Mann School Girls*

| PERIOD OF MAX. GROWTH | INTERVAL AROUND PERIOD OF MAXIMUM GROWTH | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | — .5 to + .5 | —1.5 to +1.5 | —2.5 to +2.5 | —3.5 to +3.5 | —4.5 to +4.5 | —5.5 to +5.5 | —6.5 to +6.5 | |
| 9-10 | 8.1 | 21.4 | 32.9 | 41.5 | 50.4 | ... | ... | Non-Hebrew |
| | ... | ... | ... | ... | ... | ... | ... | Hebrew |
| 10-11 | 8.1 | 21.0 | 30.9 | 39.3 | 46.6 | 58.3 | ... | Non-Hebrew |
| | 7.7 | 19.7 | 29.3 | 37.8 | 44.6 | ... | ... | Hebrew |
| 11-12 | 7.5 | 19.3 | 27.9 | 35.0 | 41.6 | 48.4 | 55.4 | Non-Hebrew |
| | 7.4 | 19.1 | 27.9 | 35.2 | 41.6 | 48.2 | ... | Hebrew |
| 12-13 | 7.1 | 18.0 | 25.7 | 32.1 | 38.2 | 44.2 | 50.5 | Non-Hebrew |
| | 7.0 | 17.5 | 25.0 | 31.3 | 37.4 | 43.6 | 49.8 | Hebrew |
| 13-14 | 6.9 | 17.1 | 24.2 | 30.1 | 35.4 | 41.1 | ... | Non-Hebrew |
| | 6.6 | 16.6 | 23.7 | 29.6 | 35.2 | 40.6 | 45.8 | Hebrew |

*b. Boys*

| PERIOD OF MAX. GROWTH | INTERVAL AROUND PERIOD OF MAXIMUM GROWTH | | | | | |
|---|---|---|---|---|---|---|
| | — .5 to + .5 | —1.5 to +1.5 | —2.5 to +2.5 | —3.5 to +3.5 | —4.5 to +4.5 | |
| 12-13 | 10.0 | 23.2 | 32.2 | 38.0 | ... | Newark Academy |
| | 10.9 | ... | ... | ... | ... | City College |
| 13-14 | 9.2 | 21.7 | 30.1 | 37.0 | ... | Newark Academy |
| | 9.9 | 22.7 | ... | ... | ... | City College |
| 14-15 | 9.1 | 21.5 | 29.3 | 35.4 | ... | Newark Academy |
| | 9.1 | 20.7 | 27.9 | ... | ... | City College |
| 15-16 | 8.8 | 20.4 | 27.8 | 33.3 | ... | Newark Academy |
| | 8.2 | 18.9 | 25.6 | 29.8 | ... | City College |
| 16-17 | 8.7 | 20.0 | 27.9 | 34.5 | ... | Newark Academy |
| | 7.9 | 18.0 | 24.4 | 28.8 | 32.1 | City College |

period of maximum rate of growth. Table 13 shows that the intensity of growth is the less, the later adolescence. The total amount of growth

TABLE 14

*Total Increment in Stature During Various Intervals Around the Date of First Menstruation*

*Horace Mann School Girls*

| MENSTRUATION DATE | INTERVAL AROUND MENSTRUATION DATE | | | | |
|---|---|---|---|---|---|
| | — .5 to + .5 | —1.5 to +1.5 | —2.5 to +2.5 | —3.5 to +3.5 | —4.5 to +4.5 |
| 10-11 | 8.2 | 20.7 | 30.5 | ... | ... |
| 11-12 | 7.7 | 21.5 | 31.5 | 39.1 | ... |
| 12-13 | 6.7 | 18.2 | 26.8 | 33.1 | 39.0 |
| 13-14 | 7.1 | 17.4 | 23.4 | 28.6 | 34.5 |
| 14-15 | 6.5 | 16.8 | 24.8 | 30.9 | 37.5 |
| 15-16 | 6.3 | 16.7 | 25.2 | 30.6 | ... |

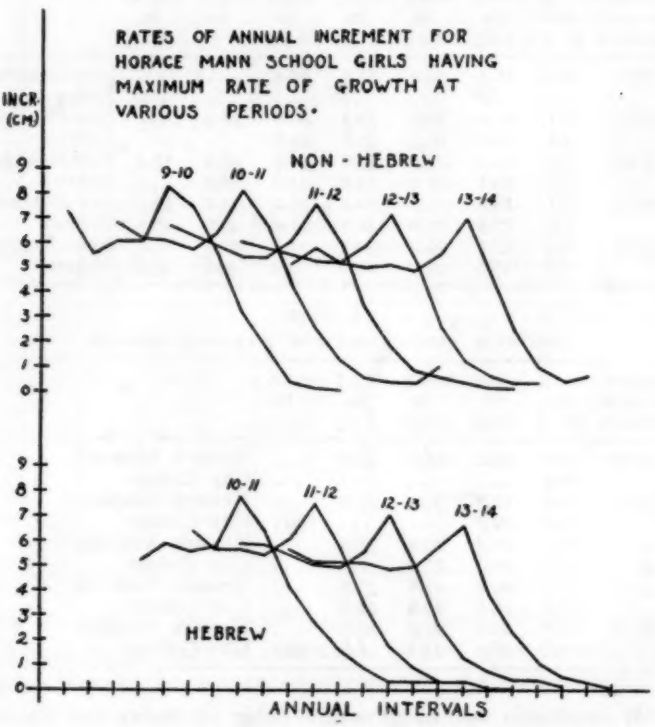


FIG. 3

TABLE 15

*Mean Increment for Horace Mann Girls With Same Time of Acceleration*

*Non-Hebrew Girls*

| TIME OF ACCELERATION | | AGE INTERVAL 5-6 yrs. | 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 | 19-20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9-10 yrs. | Mean | 7.2 | 5.5 | 6.0 | 6.0 | 8.1 | 7.3 | 5.5 | 3.1 | 1.7 | .3 | .1 | 0 | .. | .. | .. |
| | f. | 2 | 5 | 7 | 8 | 8 | 8 | 8 | 6 | 4 | 4 | 2 | 1 | .. | .. | .. |
| 10-11 | Mean | 6.7 | 6.1 | 6.0 | 5.7 | 6.3 | 8.1 | 6.6 | 4.2 | 2.4 | 1.2 | .5 | .3 | .3 | .5 | .. |
| | f. | 5 | 17 | 28 | 34 | 44 | 44 | 44 | 41 | 35 | 29 | 26 | 22 | 11 | 6 | .. |
| 11-12 | Mean | 6.7 | 6.3 | 5.8 | 5.4 | 5.4 | 6.0 | 7.5 | 5.8 | 3.2 | 1.7 | .8 | .5 | .2 | .1 | .1 |
| | f. | 23 | 44 | 58 | 69 | 87 | 101 | 101 | 101 | 98 | 90 | 83 | 68 | 37 | 16 | 9 |
| 12-13 | Mean | ... | 6.0 | 5.7 | 5.5 | 5.2 | 5.2 | 5.8 | 7.1 | 5.1 | 2.5 | 1.2 | .6 | .3 | .3 | .. |
| | f. | ... | 23 | 42 | 55 | 63 | 78 | 86 | 86 | 86 | 84 | 77 | 66 | 37 | 17 | .. |
| 13-14 | Mean | ... | 5.1 | 5.7 | 5.1 | 4.9 | 5.0 | 4.8 | 5.5 | 6.9 | 4.7 | 2.3 | .9 | .4 | .6 | .. |
| | f. | ... | 9 | 17 | 23 | 33 | 43 | 46 | 49 | 49 | 48 | 45 | 40 | 22 | 11 | .. |
| *Hebrew Girls* | | | | | | | | | | | | | | | | |
| 10-11 | Mean | ... | 5.2 | 5.8 | 5.5 | 5.7 | 7.7 | 6.3 | 4.1 | 2.7 | 1.6 | .8 | .4 | .4 | .3 | .. |
| | f. | ... | 8 | 18 | 21 | 22 | 22 | 22 | 21 | 20 | 18 | 17 | 17 | 12 | 4 | .. |
| 11-12 | Mean | ... | 6.3 | 5.6 | 5.6 | 5.4 | 6.0 | 7.4 | 5.7 | 3.4 | 1.7 | .8 | .3 | .3 | .1 | .1 |
| | f. | ... | 25 | 31 | 43 | 52 | 61 | 61 | 61 | 60 | 54 | 52 | 40 | 28 | 14 | 11 |
| 12-13 | Mean | ... | 5.8 | 5.8 | 5.4 | 5.0 | 4.9 | 5.5 | 7.0 | 5.0 | 2.6 | 1.3 | .7 | .4 | .4 | .2 |
| | f. | ... | 16 | 35 | 44 | 55 | 62 | 63 | 63 | 63 | 61 | 60 | 48 | 37 | 24 | 12 |
| 13-14 | Mean | ... | 5.6 | 5.1 | 5.1 | 5.1 | 4.8 | 4.9 | 5.7 | 6.6 | 4.3 | 2.2 | 1.1 | .5 | .3 | .1 |
| | f. | ... | 7 | 14 | 21 | 29 | 31 | 36 | 36 | 36 | 36 | 34 | 30 | 21 | 10 | 6 |

achieved during a limited interval is the greater, the earlier adolescence.[6] The same phenomenon may be observed among girls when classified according to the time of first menstruation. The earlier it occurs, the more intense is the amount of growth in a given interval (Table 14). The actual annual increments for years preceding and following the date of maximum growth are given in Table 15, (Fig. 3). The character of the curves proves clearly that the period of development is a continuum, that among the group with early adolescence growth proceeds rapidly with great intensity, while among those with later adol-

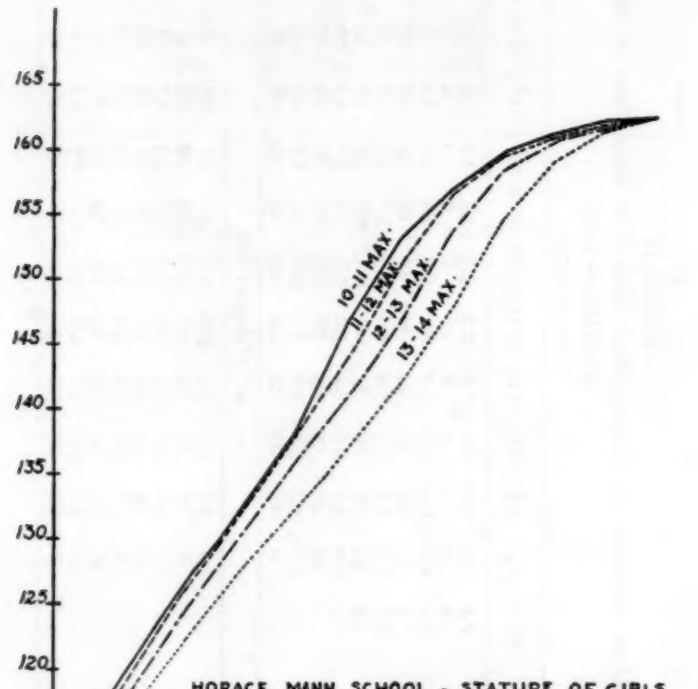


FIG. 4

[6] I have pointed this out for the Newark Academy material in *Science*, 72 (1930), p. 48.

escence the whole growth period is slow. This can be shown also by a study of those girls who have the same stature at 17 years (Table 17c). The table and the diagram (Fig. 4) show that those who are accelerated or retarded keep that position from six years up.

We have no data for the first six years of life. We have to ask whether the earlier years belong in the same way to the more or less rapid developmental cycles which are found in the period from 6 to 17 years in girls.

It is still more important to inquire whether the parts of the whole life cycle are so correlated that the intensity of physiological change which is indicated by the length of the developmental period continues in later life, including senescence and death. We have no data that would enable us to answer this question, for while it is known that some individuals or even families have a long, others a short life cycle, we have no information regarding the possible relation of these to youthful growth and development. Quite recently Dr. Felix Bernstein has

TABLE 16

*Years of Life After Examination*

(F. Bernstein)

| AGE | SUBNORMAL PRESBYOPIA | | NORMAL PRESBYOPIA | | SUPERNORMAL PRESBYOPIA | |
|---|---|---|---|---|---|---|
| *Years* | *Years* | *Cases* | *Years* | *Cases* | *Years* | *Cases* |
| 40-43 | ... | .... | 20.2 | (21) | 15.5 | ( 6) |
| 44-49 | 24.3 | (26) | 16.5 | (33) | 13.9 | (32) |
| 50-53 | 23.2 | (31) | 18.9 | (34) | 15.5 | (51) |
| 54-58 | 19.8 | (55) | 13.9 | (26) | 11.2 | (29) |
| 59-63 | 13.4 | (23) | 10.3 | (14) | 11.4 | (43) |
| 64 | 10.9 | (44) | 9.9 | (41) | 6.4 | (22) |

shown that an early death by arteriosclerosis is related to early development of presbyopia. I repeat here his table [1] and this may indicate that the life cycle continues to a certain extent as a unit. This question cannot be answered without a thorough investigation of the sequence of physiological changes during an adequate number of complete life cycles.

To revert to the amount of growth around the time of maximum rate, Table 13a (p. 333) seems to indicate that the intensity of growth is

[1] *Zeitschrift für die gesamte Versicherungs-Wissenschaft*, 1931, Volume 31, p. 150.

a trifle lower among the Hebrew girls but the difference is hardly relevant. It is, however, corroborated by a comparison of City College and Newark Academy boys (Table 13b, p. 333). As pointed out before (p. 316) the rate of growth of City College boys with early adolescence is greater than that of Newark Academy boys, while for those with late adolescence the Newark boys exceed those of City College. On account of the difference in social background of these schools it is impossible to decide whether the marked difference between the two groups is due to heredity or to social conditions. The slight difference among the Hebrew and non-Hebrew Horace Mann School girls suggests that the difference, if borne out by larger numbers, should rather be ascribed to environmental causes.

### HEREDITARY AND ENVIRONMENTAL DETERMINANTS OF THE PERIOD OF GROWTH

We have seen before that, so far as our data permit us to judge, the period of maximum growth has no appreciable influence upon adult stature, and that, furthermore, in our material no racial factor can be detected which determines the period of growth. It is quite probable that such influences do exist in family lines, but in each whole series the environmental determinants must be much more powerful than those due to heredity, because the single genetic lines composing each series vary considerably among themselves, and because similar types of genetic lines are represented with similar frequencies among the different series. On the other hand each series has its own characteristic environmental background.

On the basis of this theory we might expect that individuals who have the same stature at an early age, if subdivided according to the period of maximum rate of growth, would reflect the hereditary elements of growth more clearly than the whole mass of individuals. Those accelerated would have attained a certain stature at the given age on account of their acceleration, and it might be expected that as adults they would prove to belong to a short type, while those retarded would be more likely to belong to a tall type. In this manner the influence of retardation would be eliminated and we could obtain a clearer picture of the hereditary composition of the series. Table 17, (Fig. 5),

TABLE 17a

*Stature at Each Age of Horace Mann Girls With Same Time of Maximum Rate of Growth and Same Stature at 8 Years*

| TIME OF MAX. | AGE 6 yrs. | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Stature at 8 Years—117.5* | | | | | | | |
| 10-11 | ..... | ..... | ..... | 123.0 3 | 129.0 3 | 137.5 3 | 144.3 3 | 147.6 3 | 149.8 3 | 150.7 3 | 151.5 3 | 151.7 3 |
| 11-12 | ..... | ..... | ..... | 122.4 4 | 126.4 4 | 130.9 4 | 137.9 4 | 144.2 4 | 148.4 4 | 150.9 4 | 152.4 4 | 153.2 3 |
| 12-13 | ..... | ..... | ..... | 122.5 17 | 127.2 17 | 131.8 17 | 137.4 17 | 144.3 17 | 149.0 17 | 151.9 16 | 152.8 14 | 153.5 11 |
| 13-14 | ..... | ..... | ..... | 122.6 13 | 127.5 13 | 132.0 13 | 136.5 13 | 141.6 13 | 147.4 13 | 151.6 13 | 153.8 12 | 155.0 10 |
| | | | | | *Stature at 8 Years—122.5* | | | | | | | |
| 10-11 | ..... | ..... | ..... | 127.9 15 | 133.9 15 | 141.9 15 | 148.2 15 | 152.5 15 | 154.7 13 | 156.6 12 | 157.5 11 | 157.6 10 |
| 11-12 | ..... | ..... | ..... | 127.8 32 | 133.0 32 | 138.9 32 | 146.0 32 | 151.8 32 | 155.2 32 | 156.9 30 | 157.7 29 | 157.9 23 |
| 12-13 | ..... | ..... | ..... | 127.9 28 | 133.1 28 | 138.3 28 | 144.1 28 | 151.2 28 | 156.4 28 | 158.8 27 | 160.0 26 | 160.6 24 |
| 13-14 | ..... | ..... | ..... | 127.5 13 | 132.0 13 | 136.7 13 | 141.3 13 | 147.0 13 | 153.8 13 | 158.2 13 | 160.4 13 | 161.8 12 |
| | | | | | *Stature at 8 Years—127.5* | | | | | | | |
| 10-11 | 115.7 8 | 121.7 17 | 127.5 22 | 133.3 22 | 139.2 22 | 147.1 22 | 153.6 22 | 157.9 21 | 160.7 19 | 162.0 15 | 162.9 13 | 163.1 13 |
| 11-12 | 115.3 24 | 121.8 31 | 127.5 41 | 133.0 41 | 138.5 41 | 144.5 41 | 151.8 41 | 157.5 41 | 160.6 41 | 162.0 39 | 162.5 35 | 163.0 31 |
| 12-13 | 115.6 18 | 121.5 30 | 127.5 37 | 133.1 37 | 138.2 37 | 143.2 37 | 148.9 37 | 156.0 37 | 161.2 37 | 163.7 34 | 164.8 31 | 165.6 26 |
| 13-14 | 115.4 7 | 121.4 12 | 127.5 13 | 132.5 13 | 137.4 13 | 142.6 13 | 147.5 13 | 153.1 13 | 160.1 13 | 164.4 13 | 166.5 12 | 167.4 11 |
| | | | | | *Stature at 8 Years—132.5* | | | | | | | |
| 10-11 | ..... | ..... | ..... | 138.0 13 | 144.2 13 | 151.9 13 | 158.2 13 | 162.2 10 | 164.1 9 | 165.2 9 | 165.7 8 | 166.5 6 |
| 11-12 | ..... | ..... | ..... | 138.0 25 | 143.6 25 | 149.6 25 | 157.0 25 | 162.6 25 | 165.7 23 | 167.1 20 | 167.9 17 | 168.4 14 |
| 12-13 | ..... | ..... | ..... | 138.3 15 | 143.7 15 | 148.9 15 | 154.7 15 | 161.7 15 | 166.5 15 | 168.7 15 | 169.4 14 | 169.7 11 |
| 13-14 | ..... | ..... | ..... | 137.7 4 | 142.7 4 | 148.0 4 | 153.2 4 | 158.9 4 | 165.3 4 | 169.7 4 | 172.4 4 | 175.0 3 |
| | | | | | *Stature at 8 Years—137.5* | | | | | | | |
| 11-12 | ..... | ..... | ..... | 143.3 9 | 148.9 9 | 155.0 9 | 163.3 9 | 169.5 9 | 173.0 8 | 175.7 5 | 176.5 5 | 176.7 4 |

TABLE 17b

*Stature at Each Age of Horace Mann Girls With Same Time of Maximum Rate of Growth and Same Stature at 10 Years*

| TIME OF MAX. | AGE 6 yrs. | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Stature at 10 Years—127.5* | | | | | | | |
| 11-12 | 109.6 3 | 114.5 5 | 118.9 6 | 123.4 6 | 127.5 7 | 132.8 7 | 139.7 7 | 145.8 7 | 149.9 7 | 151.9 7 | 153.0 7 | 153.1 4 |
| 12-13 | 107.2 5 | 112.7 10 | 117.9 13 | 122.7 14 | 127.5 17 | 132.0 17 | 137.2 17 | 144.1 17 | 149.0 17 | 152.1 16 | 153.6 5 | 154.2 12 |
| 13-14 | 108.3 3 | 112.8 8 | 117.8 12 | 122.8 15 | 127.5 21 | 132.3 21 | 137.1 21 | 142.5 21 | 148.7 21 | 153.3 21 | 155.6 21 | 156.9 19 |
| | | | | | *Stature at 10 Years—132.5* | | | | | | | |
| 10-11 | 112.1 5 | 116.8 10 | 121.8 12 | 126.7 15 | 132.5 15 | 140.1 15 | 146.6 15 | 150.9 15 | 153.3 13 | 155.2 12 | 156.0 11 | 156.5 10 |
| 11-12 | 110.3 13 | 116.9 17 | 122.1 22 | 127.5 30 | 132.5 35 | 138.4 35 | 145.8 35 | 151.5 35 | 154.9 35 | 156.9 34 | 157.7 32 | 157.5 22 |
| 12-13 | 109.9 8 | 116.7 17 | 122.2 25 | 127.4 32 | 132.5 39 | 137.7 39 | 143.4 39 | 150.4 39 | 155.4 39 | 157.8 39 | 159.0 37 | 159.6 34 |
| 13-14 | 111.9 6 | 118.1 10 | 122.8 15 | 127.9 22 | 132.5 25 | 137.1 25 | 141.8 25 | 147.3 25 | 154.0 25 | 158.5 25 | 160.8 23 | 161.7 20 |
| | | | | | *Stature at 10 Years—137.5* | | | | | | | |
| 10-11 | 114.3 8 | 120.2 14 | 125.9 18 | 131.4 22 | 137.5 22 | 145.8 22 | 152.3 22 | 156.5 22 | 158.7 21 | 159.8 19 | 160.5 18 | 160.6 16 |
| 11-12 | 114.5 22 | 120.9 28 | 126.8 39 | 132.1 51 | 137.5 59 | 143.5 59 | 150.9 59 | 156.7 59 | 159.9 59 | 161.5 54 | 162.3 50 | 162.7 41 |
| 12-13 | 115.1 18 | 121.0 30 | 126.9 36 | 132.5 40 | 137.5 45 | 142.7 45 | 148.5 45 | 155.6 45 | 160.8 45 | 163.4 41 | 164.5 38 | 165.2 30 |
| 13-14 | 116.6 5 | 122.2 9 | 127.8 11 | 132.8 15 | 137.5 18 | 142.6 18 | 147.4 18 | 152.7 18 | 159.6 18 | 164.2 18 | 166.4 17 | 167.2 17 |
| | | | | | *Stature at 10 Years—142.5* | | | | | | | |
| 10-11 | 117.7 8 | 124.5 16 | 130.4 18 | 136.4 19 | 142.5 19 | 150.3 19 | 156.9 19 | 161.4 15 | 164.3 13 | 166.0 10 | 166.9 8 | 167.2 8 |
| 11-12 | 118.6 20 | 124.9 25 | 130.9 30 | 136.8 35 | 142.5 42 | 148.7 42 | 156.2 28 | 161.8 42 | 165.1 40 | 166.7 36 | 167.3 33 | 167.8 31 |
| 12-13 | 118.5 7 | 125.1 15 | 131.2 18 | 137.0 22 | 142.5 25 | 147.5 25 | 153.2 25 | 160.5 25 | 165.2 25 | 167.2 25 | 168.3 24 | 169.2 20 |
| 13-14 | ..... | 124.8 2 | 131.2 4 | 136.8 7 | 142.5 7 | 148.3 7 | 153.4 7 | 159.3 7 | 166.1 7 | 170.1 7 | 172.0 7 | 173.4 6 |
| | | | | | *Stature at 10 Years—147.5* | | | | | | | |
| 10-11 | 122.7 1 | 129.7 3 | 135.5 4 | 140.6 6 | 147.5 6 | 155.5 6 | 161.7 6 | 165.4 6 | 167.5 5 | 168.3 4 | 168.7 4 | 169.7 3 |
| 11-12 | 123.6 10 | 130.2 10 | 136.3 11 | 141.8 12 | 147.5 14 | 153.2 14 | 161.2 14 | 166.8 14 | 170.8 12 | 172.9 9 | 173.6 9 | 174.8 8 |
| 12-13 | 122.6 2 | 128.1 4 | 134.8 4 | 141.3 5 | 147.5 7 | 152.7 7 | 158.6 7 | 165.7 7 | 170.8 7 | 173.3 7 | 174.2 6 | 174.7 4 |

TABLE 17c

*Stature at Each Age of Horace Mann Girls With Same Time of Maximum Rate of*

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11-12 | 123.6 | 10 | 130.2 | 10 | 136.3 | 11 | 141.8 | 12 | 147.5 | 14 | 153.2 | 14 | 161.2 | 14 | 166.8 | 14 | 170.8 | 12 | 172.9 | 9 | 173.6 | 9 | 174.8 | 8 |
| 12-13 | 122.6 | 2 | 128.1 | 4 | 134.8 | 4 | 141.3 | 5 | 147.5 | 7 | 152.7 | 7 | 158.6 | 7 | 165.7 | 7 | 170.8 | 7 | 173.3 | 7 | 174.2 | 6 | 174.7 | 4 |

TABLE 17c

*Stature at Each Age of Horace Mann Girls With Same Time of Maximum Rate of Growth and Same Stature at 17 Years*

| TIME OF MAX. | AGE 6 yrs. | | 7 | | 8 | | 9 | | 10 | | 11 | | 12 | | 13 | | 14 | | 15 | | 16 | | 17 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Stature at 17 Years—152.5* | | | | | | | | | | | | | | | | | | | | | | | | |
| 10-11 | ..... | | 109.6 | 2 | 116.2 | 3 | 122.1 | 4 | 128.8 | 4 | 136.1 | 4 | 143.0 | 4 | 147.5 | 4 | 150.1 | 4 | 151.6 | 4 | 152.2 | 4 | 152.5 | 4 |
| 11-12 | 106.5 | 2 | 114.5 | 6 | 119.6 | 8 | 123.9 | 9 | 128.5 | 9 | 134.0 | 9 | 140.9 | 9 | 146.3 | 9 | 149.5 | 9 | 151.3 | 9 | 152.4 | 9 | 152.5 | 9 |
| 12-13 | 109.7 | 2 | 112.2 | 5 | 117.2 | 5 | 120.9 | 7 | 126.1 | 9 | 130.6 | 9 | 135.8 | 9 | 142.3 | 9 | 147.4 | 9 | 150.4 | 9 | 151.9 | 9 | 152.5 | 9 |
| 13-14 | ..... | | 113.4 | 2 | 118.0 | 4 | 123.3 | 4 | 126.9 | 5 | 130.8 | 6 | 135.9 | 7 | 140.9 | 7 | 146.9 | 7 | 150.4 | 7 | 151.8 | 7 | 152.5 | 7 |
| *Stature at 17 Years—157.5* | | | | | | | | | | | | | | | | | | | | | | | | |
| 10-11 | 112.9 | 5 | 118.2 | 8 | 123.4 | 11 | 128.9 | 13 | 135.0 | 13 | 143.0 | 13 | 149.0 | 13 | 153.1 | 13 | 155.3 | 13 | 156.8 | 13 | 157.2 | 13 | 157.5 | 13 |
| 11-12 | 111.6 | 12 | 117.8 | 13 | 123.4 | 18 | 128.6 | 22 | 133.8 | 24 | 139.8 | 24 | 146.9 | 24 | 152.3 | 24 | 155.1 | 24 | 156.5 | 24 | 157.1 | 24 | 157.5 | 24 |
| 12-13 | 109.2 | 5 | 115.8 | 10 | 121.1 | 19 | 126.2 | 22 | 130.8 | 30 | 135.6 | 31 | 141.0 | 31 | 147.8 | 31 | 152.7 | 31 | 155.3 | 31 | 156.6 | 31 | 157.5 | 31 |
| 13-14 | 109.9 | 3 | 114.3 | 7 | 119.4 | 10 | 124.5 | 14 | 129.0 | 17 | 133.6 | 18 | 138.1 | 18 | 143.3 | 18 | 149.6 | 18 | 154.0 | 18 | 156.4 | 18 | 157.5 | 18 |
| *Stature at 17 Years—162.5* | | | | | | | | | | | | | | | | | | | | | | | | |
| 10-11 | 115.5 | 3 | 121.9 | 6 | 127.7 | 8 | 132.8 | 10 | 138.4 | 10 | 146.8 | 10 | 153.2 | 10 | 157.1 | 10 | 159.9 | 10 | 161.4 | 10 | 162.3 | 10 | 162.5 | 10 |
| 11-12 | 114.7 | 12 | 121.2 | 15 | 127.2 | 24 | 132.6 | 31 | 138.2 | 35 | 144.1 | 35 | 151.2 | 35 | 156.6 | 35 | 159.7 | 35 | 161.3 | 35 | 162.1 | 35 | 162.5 | 35 |
| 12-13 | 113.7 | 12 | 119.8 | 20 | 125.4 | 23 | 130.8 | 25 | 136.2 | 28 | 141.2 | 31 | 146.8 | 31 | 153.8 | 31 | 158.7 | 31 | 160.9 | 31 | 161.9 | 31 | 162.5 | 31 |
| 13-14 | 112.8 | 3 | 117.8 | 5 | 123.2 | 9 | 128.0 | 13 | 132.2 | 20 | 137.2 | 22 | 142.1 | 22 | 147.9 | 22 | 154.7 | 22 | 159.4 | 22 | 161.7 | 22 | 162.5 | 22 |
| *Stature at 17 Years—167.5* | | | | | | | | | | | | | | | | | | | | | | | | |
| 10-11 | 121.6 | 5 | 126.3 | 7 | 131.7 | 9 | 137.4 | 9 | 143.3 | 9 | 150.6 | 9 | 157.1 | 9 | 161.6 | 9 | 164.8 | 9 | 166.3 | 9 | 167.0 | 9 | 167.5 | 9 |
| 11-12 | 117.2 | 11 | 124.0 | 15 | 129.8 | 16 | 135.2 | 20 | 140.7 | 25 | 147.1 | 25 | 154.7 | 25 | 161.0 | 25 | 164.5 | 25 | 166.2 | 25 | 167.1 | 25 | 167.5 | 25 |
| 12-13 | 115.6 | 5 | 122.2 | 16 | 127.8 | 19 | 133.4 | 22 | 138.5 | 24 | 144.0 | 26 | 149.9 | 26 | 157.3 | 26 | 162.6 | 26 | 165.4 | 26 | 166.8 | 26 | 167.5 | 26 |
| 13-14 | 116.4 | 4 | 121.6 | 5 | 126.5 | 6 | 132.3 | 11 | 137.5 | 12 | 142.5 | 13 | 147.0 | 14 | 152.5 | 14 | 159.5 | 14 | 164.4 | 14 | 166.5 | 14 | 167.5 | 14 |
| *Stature at 17 Years—172.5* | | | | | | | | | | | | | | | | | | | | | | | | |
| 11-12 | 124.3 | 4 | 129.2 | 5 | 134.4 | 6 | 139.0 | 10 | 144.5 | 10 | 150.5 | 10 | 158.1 | 10 | 164.5 | 10 | 168.8 | 10 | 171.4 | 10 | 172.3 | 10 | 172.5 | 10 |
| 12-13 | 118.7 | 3 | 125.6 | 5 | 131.8 | 6 | 138.0 | 8 | 143.9 | 11 | 149.2 | 12 | 155.3 | 12 | 162.6 | 12 | 168.1 | 12 | 170.8 | 12 | 171.9 | 12 | 172.5 | 12 |
| 13-14 | ..... | | 124.0 | 4 | 130.1 | 5 | 134.4 | 7 | 139.4 | 7 | 145.1 | 7 | 150.3 | 7 | 156.3 | 7 | 163.2 | 7 | 167.9 | 7 | 170.8 | 7 | 172.5 | 7 |

TABLE 17d

*Stature at Each Age of City College Boys With Same Time of Maximum Rate of Growth and Same Stature at 13 Years*

| ACCEL-ERATION | AGE 12 yrs. | | 13 | | 14 | | 15 | | 16 | | 17 | | 18 | | 19 | | 20 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *Stature at 13 Years*—130-134.9 | | | | | | | | | | | | |
| 14-15 | 129.5 | 1 | 132.5 | 2 | 139.7 | 2 | 147.1 | 2 | 152.0 | 2 | 154.0 | 2 | 154.7 | 1 | 155.6 | 1 | 156.9 | 1 |
| 15-16 | ..... | | 132.5 | 2 | 139.1 | 2 | 144.8 | 2 | 152.0 | 2 | 157.4 | 2 | 159.3 | 2 | 160.2 | 2 | 159.1 | 1 |
| | | | | | | *Stature at 13 Years*—135-139.9 | | | | | | | | | | | | |
| 13-14 | 132.5 | 1 | 137.5 | 4 | 148.7 | 4 | 154.4 | 4 | 157.9 | 4 | 159.9 | 4 | 159.8 | 2 | 159.0 | 1 | 159.3 | 1 |
| 14-15 | 133.2 | 4 | 137.5 | 17 | 144.8 | 17 | 153.9 | 17 | 159.9 | 17 | 161.8 | 14 | 162.9 | 13 | 162.3 | 7 | 161.6 | 5 |
| 15-16 | ..... | | 137.5 | 6 | 142.6 | 6 | 149.5 | 6 | 159.1 | 6 | 164.3 | 5 | 166.9 | 5 | 166.0 | 3 | 166.1 | 1 |
| | | | | | | *Stature at 13 Years*—140-144.9 | | | | | | | | | | | | |
| 13-14 | 136.1 | 6 | 142.5 | 21 | 153.5 | 21 | 160.1 | 21 | 164.0 | 21 | 166.2 | 17 | 166.9 | 13 | 167.0 | 12 | 166.5 | 6 |
| 14-15 | 140.5 | 3 | 142.5 | 20 | 148.9 | 20 | 157.8 | 20 | 164.4 | 20 | 167.4 | 18 | 168.3 | 15 | 168.1 | 10 | 169.5 | 5 |
| 15-16 | ..... | | 142.5 | 6 | 147.3 | 6 | 153.1 | 6 | 161.0 | 6 | 165.5 | 6 | 168.6 | 4 | 167.8 | 3 | ..... | |
| | | | | | | *Stature at 13 Years*—145-149.9 | | | | | | | | | | | | |
| 13-14 | 141.3 | 5 | 147.5 | 22 | 157.6 | 22 | 164.1 | 22 | 166.5 | 20 | 167.9 | 20 | 168.8 | 20 | 169.5 | 14 | 170.6 | 6 |
| 14-15 | 142.7 | 7 | 147.5 | 24 | 152.8 | 24 | 161.8 | 24 | 167.7 | 23 | 170.0 | 19 | 170.6 | 16 | 171.0 | 12 | 171.7 | 4 |
| 15-16 | 147.2 | 1 | 147.5 | 10 | 152.5 | 10 | 159.0 | 10 | 167.3 | 10 | 172.2 | 9 | 173.7 | 8 | 176.1 | 5 | ..... | |
| | | | | | | *Stature at 13 Years*—150-154.9 | | | | | | | | | | | | |
| 13-14 | 147.1 | 12 | 152.5 | 25 | 162.2 | 25 | 168.6 | 25 | 171.5 | 25 | 173.2 | 24 | 173.8 | 19 | 173.7 | 15 | 174.0 | 6 |
| 14-15 | 147.0 | 7 | 152.5 | 32 | 157.6 | 32 | 165.9 | 32 | 171.0 | 31 | 174.0 | 26 | 175.0 | 24 | 175.8 | 16 | 176.2 | 6 |
| 15-16 | ..... | | 152.5 | 7 | 157.0 | 7 | 163.6 | 7 | 172.1 | 7 | 176.1 | 6 | 177.9 | 6 | 179.9 | 3 | 181.3 | 2 |
| | | | | | | *Stature at 13 Years*—155-159.9 | | | | | | | | | | | | |
| 13-14 | 150.3 | 3 | 157.5 | 14 | 167.6 | 14 | 173.8 | 14 | 176.6 | 14 | 177.8 | 14 | 178.7 | 13 | 179.8 | 6 | 181.3 | 2 |
| 14-15 | 153.1 | 3 | 157.5 | 19 | 163.6 | 19 | 172.2 | 19 | 176.6 | 19 | 178.2 | 15 | 179.5 | 14 | 180.1 | 9 | 181.5 | 3 |
| 15-16 | 154.6 | 2 | 157.5 | 4 | 161.3 | 4 | 166.9 | 4 | 174.0 | 4 | 179.0 | 4 | 181.3 | 4 | 180.3 | 1 | 180.3 | 1 |
| | | | | | | *Stature at 13 Years*—160-164.9 | | | | | | | | | | | | |
| 13-14 | 153.6 | 1 | 162.5 | 6 | 171.6 | 6 | 178.3 | 6 | 181.6 | 6 | 183.2 | 5 | 184.3 | 5 | 184.2 | 3 | 188.2 | 1 |
| 14-15 | ..... | | 162.5 | 2 | 164.4 | 2 | 172.2 | 2 | 178.1 | 2 | 179.8 | 2 | 180.5 | 2 | ..... | | ..... | |
| | | | | | | *Stature at 13 Years*—165-169.9 | | | | | | | | | | | | |
| 13-14 | 162.0 | 1 | 167.5 | 2 | 178.2 | 2 | 183.6 | 2 | 187.9 | 1 | 189.4 | 1 | 191.1 | 1 | ..... | | ..... | |
| 14-15 | 160.9 | 1 | 167.5 | 1 | 173.1 | 1 | 180.2 | 1 | 184.3 | 1 | ..... | | ..... | | ..... | | ..... | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14-15 | ..... | | 162.5 | 2 | 164.4 | 2 | 172.2 | 2 | 178.1 | 2 | 179.8 | 2 | 180.5 | 2 | ..... | | ..... | | | |
| *Stature at 13 Years—165-169.9* | | | | | | | | | | | | | | | | | | | | |
| 13-14 | 162.0 | 1 | 167.5 | 2 | 178.2 | 2 | 183.6 | 2 | 187.9 | 1 | 189.4 | 1 | 191.1 | 1 | ..... | | ..... | | | |
| 14-15 | 160.9 | 1 | 167.5 | 1 | 173.1 | 1 | 180.2 | 1 | 184.3 | 1 | ..... | | ..... | | ..... | | ..... | | | |

TABLE 17e

*Stature at Each Age of City College Boys With Same Time of Maximum Rate of Growth and Same Stature at 17 Years*

| TIME OF MAX. GROWTH | AGE | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12 yrs. | | 13 | | 14 | | 15 | | 16 | | 17 | | 18 | | 19 | | 20 | | | |
| *Stature at 17 Years—145-149.9* | | | | | | | | | | | | | | | | | | | | |
| 16-17 | ..... | | 127.1 | 1 | 128.8 | 2 | 134.5 | 2 | 139.7 | 2 | 147.5 | 2 | 153.5 | 2 | 156.7 | 2 | 158.6 | 2 | | |
| *Stature at 17 Years—150-154.9* | | | | | | | | | | | | | | | | | | | | |
| 14-15 | 129.5 | 1 | 133.7 | 2 | 139.7 | 2 | 147.1 | 2 | 152.0 | 2 | 152.5 | 2 | 154.7 | 1 | 155.6 | 1 | 156.9 | 1 | | |
| 16-17 | ..... | | ..... | | 133.8 | 1 | 138.9 | 1 | 145.0 | 1 | 152.5 | 1 | 160.0 | 1 | 162.3 | 1 | 163.6 | 1 | | |
| *Stature at 17 Years—155-159.9* | | | | | | | | | | | | | | | | | | | | |
| 13-14 | 132.5 | 1 | 138.3 | 2 | 148.7 | 2 | 153.4 | 2 | 156.8 | 2 | 157.5 | 2 | 158.5 | 1 | 159.0 | 1 | 159.3 | 1 | | |
| 14-15 | 134.1 | 1 | 136.3 | 4 | 141.7 | 8 | 151.4 | 8 | 156.6 | 8 | 157.5 | 8 | 159.4 | 8 | 159.5 | 6 | 159.1 | 5 | | |
| 15-16 | ..... | | 134.8 | 3 | 139.6 | 6 | 145.2 | 6 | 152.6 | 6 | 157.5 | 6 | 160.3 | 6 | 160.8 | 5 | 159.1 | 2 | | |
| 16-17 | ..... | | ..... | | 141.3 | 2 | 145.0 | 2 | 150.1 | 2 | 157.5 | 2 | 161.8 | 2 | 163.7 | 2 | 161.3 | 1 | | |
| *Stature at 17 Years—160-164.9* | | | | | | | | | | | | | | | | | | | | |
| 13-14 | 138.3 | 5 | 143.2 | 13 | 152.9 | 13 | 158.6 | 13 | 161.2 | 13 | 162.5 | 13 | 163.2 | 12 | 163.9 | 9 | 163.2 | 3 | | |
| 14-15 | 133.4 | 2 | 139.9 | 12 | 146.0 | 22 | 155.2 | 22 | 160.6 | 22 | 162.5 | 22 | 164.3 | 21 | 164.5 | 17 | 164.5 | 9 | | |
| 15-16 | ..... | | 140.1 | 5 | 145.7 | 17 | 150.8 | 17 | 158.4 | 17 | 162.5 | 17 | 166.3 | 15 | 167.3 | 11 | 167.7 | 2 | | |
| 16-17 | 138.3 | 2 | 140.4 | 4 | 143.1 | 9 | 147.9 | 9 | 153.6 | 9 | 162.5 | 9 | 165.9 | 9 | 167.6 | 7 | 169.6 | 5 | | |

TABLE 17e—*Continued*

*Stature at Each Age of City College Boys With Same Time of Maximum Rate of Growth and Same Stature at 17 Years*

| TIME OF MAX. GROWTH | AGE | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12 yrs. | | 13 | | 14 | | 15 | | 16 | | 17 | | 18 | | 19 | | 20 | |
| | | | | | | *Stature at 17 Years*—165-169.9 | | | | | | | | | | | | |
| 13-14 | 141.6 | 4 | 146.3 | 18 | 156.5 | 18 | 162.7 | 18 | 166.3 | 18 | 167.5 | 18 | 168.7 | 14 | 169.0 | 10 | 169.2 | 6 |
| 14-15 | 141.0 | 6 | 144.0 | 24 | 149.8 | 36 | 158.9 | 36 | 164.7 | 36 | 167.5 | 36 | 168.4 | 30 | 168.9 | 20 | 170.2 | 11 |
| 15-16 | ..... | | 144.1 | 6 | 147.8 | 27 | 154.1 | 27 | 162.7 | 27 | 167.5 | 27 | 169.6 | 25 | 171.3 | 16 | 171.0 | 8 |
| 16-17 | ..... | | 146.1 | 3 | 150.0 | 5 | 153.9 | 5 | 159.3 | 5 | 167.5 | 5 | 171.2 | 4 | 174.6 | 2 | ..... | |
| | | | | | | *Stature at 17 Years*—170-174.9 | | | | | | | | | | | | |
| 13-14 | 146.4 | 12 | 151.9 | 30 | 161.0 | 30 | 167.5 | 30 | 170.8 | 30 | 172.5 | 30 | 172.9 | 26 | 173.0 | 20 | 172.9 | 8 |
| 14-15 | 145.7 | 6 | 150.2 | 30 | 155.3 | 51 | 164.3 | 51 | 169.9 | 51 | 172.5 | 51 | 173.8 | 42 | 174.5 | 25 | 175.1 | 10 |
| 15-16 | 147.2 | 1 | 147.7 | 8 | 153.2 | 19 | 159.0 | 19 | 167.1 | 19 | 172.5 | 19 | 174.4 | 17 | 175.7 | 12 | 176.1 | 5 |
| 16-17 | ..... | | 147.0 | 1 | 152.2 | 2 | 156.1 | 2 | 163.5 | 2 | 172.5 | 2 | 175.7 | 2 | 177.9 | 2 | 179.4 | 1 |
| | | | | | | *Stature at 17 Years*—175-179.9 | | | | | | | | | | | | |
| 13-14 | 149.6 | 3 | 156.5 | 15 | 166.5 | 15 | 173.3 | 15 | 176.0 | 15 | 177.5 | 15 | 178.2 | 14 | 177.7 | 7 | 176.3 | 2 |
| 14-15 | 151.1 | 2 | 155.3 | 15 | 160.1 | 21 | 168.9 | 21 | 174.8 | 21 | 177.5 | 21 | 178.4 | 21 | 179.0 | 15 | 179.8 | 5 |
| 15-16 | 153.0 | 1 | 153.4 | 9 | 158.1 | 13 | 164.5 | 13 | 172.6 | 13 | 177.5 | 13 | 179.4 | 11 | 180.3 | 7 | 180.9 | 5 |
| | | | | | | *Stature at 17 Years*—180-184.9 | | | | | | | | | | | | |
| 13-14 | ..... | | 158.4 | 2 | 169.4 | 2 | 175.9 | 2 | 185.6 | 2 | 182.5 | 2 | 182.1 | 2 | 183.4 | 1 | ..... | |
| 14-15 | 151.8 | 3 | 157.5 | 9 | 163.3 | 9 | 172.5 | 9 | 178.0 | 9 | 182.5 | 9 | 181.7 | 8 | 183.4 | 5 | 183.6 | 1 |
| 15-16 | 156.2 | 1 | 159.3 | 1 | 164.1 | 1 | 170.0 | 1 | 176.8 | 1 | 182.5 | 1 | 185.2 | 1 | ..... | | ..... | |
| | | | | | | *Stature at 17 Years*—185-189.9 | | | | | | | | | | | | |
| 13-14 | ..... | | 162.9 | 5 | 173.2 | 5 | 181.2 | 5 | 185.2 | 5 | 187.5 | 5 | 187.9 | 5 | 187.2 | 3 | 188.5 | 2 |

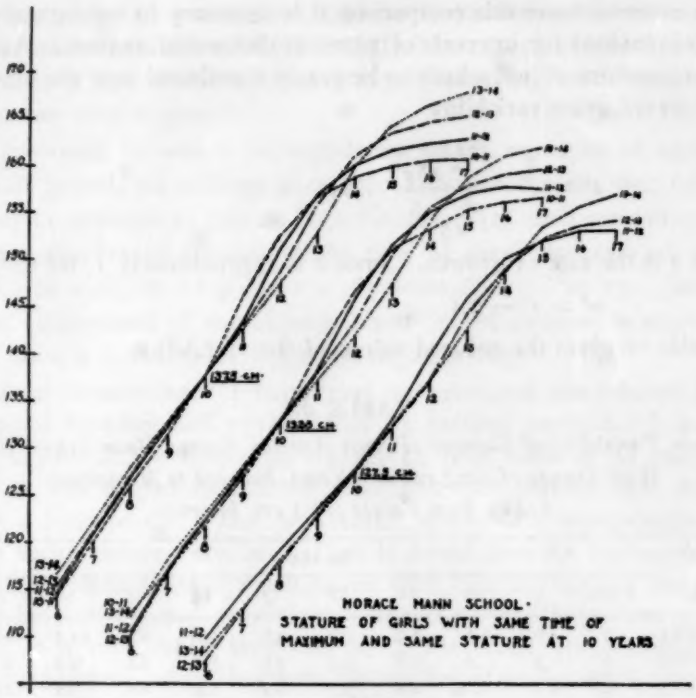


FIG. 5

which gives these data for children of the same ages, classified according to stature, shows that the expected relations between selected stature at a given age, time of maximum rate of growth and adult stature actually occur.

### VARIABILITY DUE TO HEREDITY AND TO ENVIRONMENT

It would not be justifiable to assume that all children who have their period of maximum rate of growth at the same time and who have also the same stature are identical in regard to their hereditary stature, nor have we the right to assume that for every genetic line the stature will increase in an identical way, even if the outer conditions are identical. Nevertheless, the reduction of adult variability for each class will give us a maximum that may be ascribed to either hereditary or environmental causes.

In order to make this comparison it is necessary to reduce the variabilities obtained for intervals of 5 cm., to the central moment. Assuming the numbers of individuals to be evenly distributed over the interval, the observed gross variability

$$s^2 = \sigma^2 + \int_{-2.5}^{+2.5} \frac{a^2 x^2}{5}\, dx,$$

where $a$ is the rate of growth. Since $a$ is approximately 1, we may say

$$\sigma^2 = s^2 - 2.1$$

Table 18 gives the reduced values of the variability.

TABLE 18

*Square Variability of Statures at Each Age for Horace Mann School Girls With Stature of 127.5 cm. at 8 Years, Reduced to Momentary Values from Values for 5 cm. Intervals*

| TIME OF MAX. GROWTH | AGE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 8 yrs. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 10-11 | 0 | .6 | 1.3 | 2.5 | 4.3 | 4.6 | 5.8 | 8.3 | 12.5 | 11.8 |
| 11-12 | 0 | .3 | .8 | 1.8 | 3.3 | 3.6 | 5.7 | 8.0 | 8.9 | 8.2 |
| 12-13 | 0 | 1.1 | 1.7 | 2.0 | 3.7 | 6.3 | 7.9 | 8.5 | 9.8 | 11.2 |
| 13-14 | .4 | 1.1 | 1.7 | 2.1 | 4.9 | 8.3 | 9.0 | 9.5 | 9.4 | 11.6 |
| | | | | | | | | | Avg. | 10.2 |

The average reduced value for 17 years is, for those with the same stature at 8 years,

$$\sigma^2 = 10.2$$

For the entire group regardless of period of maximum rate of growth the square of the variability is 15.0, the reduced value 12.9. The total square variability may therefore be considered to consist of the amount 10.2 just mentioned, and of 2.7 which is due to the intermingling of different lines. We have, therefore, for those with the same stature at 8 years

Variability excluding acceleration..... ± 3.2 cm.
Variability due to variety of period of acceleration... ± 1.65 cm.

It remains to be seen in how far the variability due to acceleration may be due to hereditary or environmental causes. Notwithstanding

the dependence of acceleration upon environmental conditions it would seem that many of these are eliminated when a group of identical stature at an early age is selected and grouped according to the moment of maximum rate of growth.

According to note 2 the correlation of the moments of maximum rate of growth for siblings is $+.33$. This would mean that the variability of averages of genetic lines (family lines) each consisting of an infinite number of siblings at the time of maximum rate of growth would be $\sigma\sqrt{r}$, or $1.1\sqrt{.33} = \pm .64$ years (See Table 2). Since the social background of the Horace Mann School children is much alike this value is probably largely a genetic variability.

At a former time[8] I have tried to investigate the relative importance of heredity and environment by another method. I assumed that a part of the body that reaches its final form at an early time will be less subject to external influences than another that develops over a long period. The head index reaches its approximate form very early, stature very late. If it is found that the fraternal correlation for head index is much higher than that for stature, the reason may be that external conditions continue to modify stature individually at a time when they can no longer exert an influence upon the head index. Since, however, the coefficient of fraternal correlation is only an expression of the variability of genetic lines constituting the population, it is also assumed that cephalic index and stature under stable conditions would be equally variable in the population studied, in other words that the ratio between fraternal variability and variability of the whole population would be the same for both measures. This point cannot be proved. With these limitations the further assumption is made that the external conditions affect every member of a fraternity individually. Since every family is more or less subject to similar conditions, this is not true. By making the assumption I lowered the influence of external conditions so that the resulting values were given as a maximum value of hereditary influence. I obtained thus, based on observations on East European Jews, $\pm 4.4$ cm. for the maximum of hereditary influences, $\pm 3.8$ cm. for environmental influences. The reliability of this result depends entirely upon the question whether the genetic lines have the same relative variability in regard to stature and head index.

[8] See *Zeitschrift für Ethnologie*, 45 (1913), pp. 615 *et seq.*

I have discussed the same problem from still another point of view.[9] Stature is determined by hereditary and non-hereditary influences. Assuming both to have random distribution and to be independent of each other, the average hereditary line for a value having the deviation $x$ will represent many genetic lines which in connection with the non-hereditary element will result in the deviation $x$. Therefore the fraternal variability of the whole group will be greater than the actual fraternal variability in each family. The same conditions would result, if we assume that each deviation $x$ may be brought about by various bi-parental genetic combinations alone or combined with non-hereditary influences. If we disregard selective mating, which in fairly homogeneous populations has always a very low value, the square of the variability of descendants with the selected deviations $x$ and $y$ for father and mother will be $(1 - 2r_p^2)\,\sigma^2$ where $\sigma$ expresses the variability of the total series, $r_p$ the coefficient of correlation between parents and children, those for paternal and maternal correlation being assumed as equal. This is justifiable, since there is no proof of dominance in any one of the metric characters concerned. The variability in a single family is $(1 - r_{fr})\,\sigma^2$, where $r_{fr}$ expresses the fraternal correlation,[10] assumed to be equal for all families, and for families with an infinite number of children. The difference between these two values indicates therefore the additional variability caused by the intermingling of genetic lines and by non-hereditary influences. For the stature of English families[11] the averages of these values for variabilities and correlations between fathers, mothers, children, brothers and sisters are

$$\sigma^2 = 6.58 \text{ square inches} = 42.44 \text{ square cm.}$$
$$r_p = 0.336 \qquad 1 - 2r_p^2 = 0.776$$
$$r_{fr} = 0.403 \qquad 1 - r_{fr} = 0.597$$
$$(r_{fr} - 2r_p^2)\sigma^2 = .179 \times 42.44 = 7.64$$

[9] Family Traits as Determined by Heredity and Environment. *Proceedings of the National Academy of Sciences*, 14 (1928), pp. 496-503.—The division of variability into hereditary and non-hereditary elements cannot be made in the manner suggested on pp. 502-503.

[10] The purely hereditary correlation between brothers would be greater than the empirical value $r_{fr}$, because siblings are also affected by varying environmental conditions.

[11] Data from Karl Pearson, Mathematical Contributions to the Theory of Evolution—III. *Royal Society*, 99 (1896), pp. 270, 281. The coefficients for males and females have been averaged here.

Variability due to non-hereditary influences or to intermingling of genetic lines $\pm$ 2.76

This leaves for the variability due to heredity or to identical environmental influences acting upon parents and children $\sqrt{34.8} = \pm 5.9$ cm. This would mean that the maximum amount of non-hereditary influences, excepting those that act equally upon parents and children, would be measured by the amount of $\pm$ 2.76 cm.

## SUMMARY

Increase of stature has been studied according to the periods in which the individual becomes adolescent.

1. The age at first menstruation of Hebrew and non-Hebrew girls in Horace Mann School, New York, is for either 13.1 $\pm$ 1.2 years; for Hebrew orphans 13.5 $\pm$ 1.1 years.

2. The moment of most rapid rate of growth for the first two groups is respectively 12.0 $\pm$ 1.2 and 12.1 $\pm$ 1.2 years; for boys in two schools of distinct social character, the one with non-Hebrew students, the other with many Hebrews, 14.4 $\pm$ 1.1 and 14.7 $\pm$ 1.1 years.

3. The interval between the moment of maximum rate of growth and the first menstruation is the greater the earlier the maximum rate of growth.

4. The earlier the maximum rate of growth the shorter the total period of growth.

5. The average statures for Horace Mann Hebrew girls are always a trifle below those for non-Hebrew girls. In most groups the statures of Hebrew children exceed those of non-Hebrew children in early years, while later on the reverse is the case. The former period is longest for children who are short for their ages.

6. Acceleration or retardation within the same social group has apparently no influence upon adult stature.

7. During the period of growth the average stature for a given year is the higher the earlier the maximum rate of growth and the earlier the first menstruation.

8. The growth curve is intimately related to the moment of maximum rate of growth, less so to the date of first menstruation.

9. The maximum of the variability of stature during adolescence disappears in groups having the same moments of maximum rate of growth.

10. The intensity of growth during the period of growth is the less the later adolescence. Does this imply a different tempo of physiological changes throughout life?

11. Individuals who have the same stature at an early age are as adults the shorter the earlier the moment of maximum rate of growth.

12. Different genetic lines of the Horace Mann School population have the standard variability of $\pm .64$ years for the moment of maximum rate of growth.

NOTE. The above are results of investigations undertaken by a grant from the Research Council of the Social Sciences of Columbia University.

# A BIOMETRIC STUDY OF THE RELATION BETWEEN THE EXCRETION OF CREATININE NITROGEN AND SEVERAL BODY MEASUREMENTS*

BY HOWARD H. BEARD

*From the Departments of Biochemistry, School of Medicine, Western Reserve University, Cleveland, and the Louisiana State University Medical Center, New Orleans.*

It has been assumed that at least one factor in the excretion of creatinine was the body weight of the individual. This idea was first introduced by Folin [1] who stated that "the chief factor determining the amount of creatinine eliminated appears to be the weight of the person. The proportion between body weight and the amount of creatinine in the urine is, however, not very constant. Fat or corpulent persons yield less creatinine per unit of body weight than lean ones. . . . The analytical data, as far as yet obtained, indicate that moderately corpulent persons eliminate per twenty-four hours about 20 mg. creatinine per kilo of body weight, while lean ones yield about 25 mg. per kilo." Shaffer [2] introduced the term "creatinine coefficient" (the mg. creatinine or creatinine nitrogen eliminated per kilo of body weight) to express the above relation. This coefficient varies for men from 18 to 32 and for women from 9 to 26. In terms of creatinine nitrogen the values for normal men given by Shaffer range from 7 to 11 mg. per kilo.

We should expect a small relation between the output of creatinine and the body weight. This is no doubt due to the amount of muscle tissue present in the body. Bürger [3] stated that 1 gm. of creatinine per day corresponds to 22.9 kg. of normal muscle. In addition to the body weight, several other factors, such as age, sex, muscular development and starvation, each may have an influence upon the creatinine output.

* A preliminary report of this study was presented before the Biological Division of the American Chemical Society, March 28—April 1, 1932, at New Orleans, La.

[1] Folin, O., *Amer. J. Physiol., 13,* 66 (1905).

[2] Shaffer, P. A., *Amer. J. Physiol., 23,* 1, (1908).

[3] Bürger, M., *Z. ges. exp. Med., 9,* 262 (1919).

On the other hand there are several objections to the theory that the body weight is the chief factor in the elimination of creatinine. The constancy of the daily output is not absolute. Hunter[4] states that, according to the data in the literature, the day to day variations often exceed 10 per cent and may sometimes even amount to 20 or 25 per cent. There is also a considerable range in the creatinine coefficients of men and women, which again shows that the relation is not one of strict proportionality. It is also a generally accepted fact that urinary creatinine is derived from muscle creatine (98 per cent of which is stated to be contained in the muscles). The muscle mass of the body does not usually exceed 40 per cent of the body weight and the remaining 60 per cent would then be another factor in every individual that would tend to upset the relation.

In order to test the validity of these points and also to obtain a mathematical expression for the relationship which might exist between the creatinine output and the body weight, the correlation coefficients between these two variables were calculated from data obtained from a large group of medical students fed on a normal, high and low protein diet.

## COLLECTION OF DATA

The four hundred and one, 24 hour urine analyses of creatinine nitrogen were very carefully selected from about 500 such analyses made during recent years in this laboratory. These analyses were made by the medical students themselves as part of their routine work in the course in biochemistry. To test the accuracy of these analyses an inspection of Chart 2 will show that the average creatinine nitrogen coefficient of the group falls within the limits originally set by Shaffer. The output of creatinine nitrogen on both diets gave similar figures, hence we are not dealing with incomplete urinary collections on the part of the students. Thus, for the purposes of this study, the analyses are considered correct within the experimental error of the first year medical student.

*Metabolism Periods, 8 A. M. to 8 A. M.*

1. Normal Diet. The usual diet of the student for 2 days; collection and analysis of the second 24-hour specimen of urine.

[4] Hunter, A., *Physiol. Rev.*, *2*, 586 (1922).

2. Low Protein Diet. Butter, potatoes, vegetables, fruit and candy for 2 days; collection and analysis of second 24-hour specimen of urine.

All urines were preserved with 5 cc. of chloroform and the creatinine estimations were carried out in duplicate by each student using Folin's [5] method.

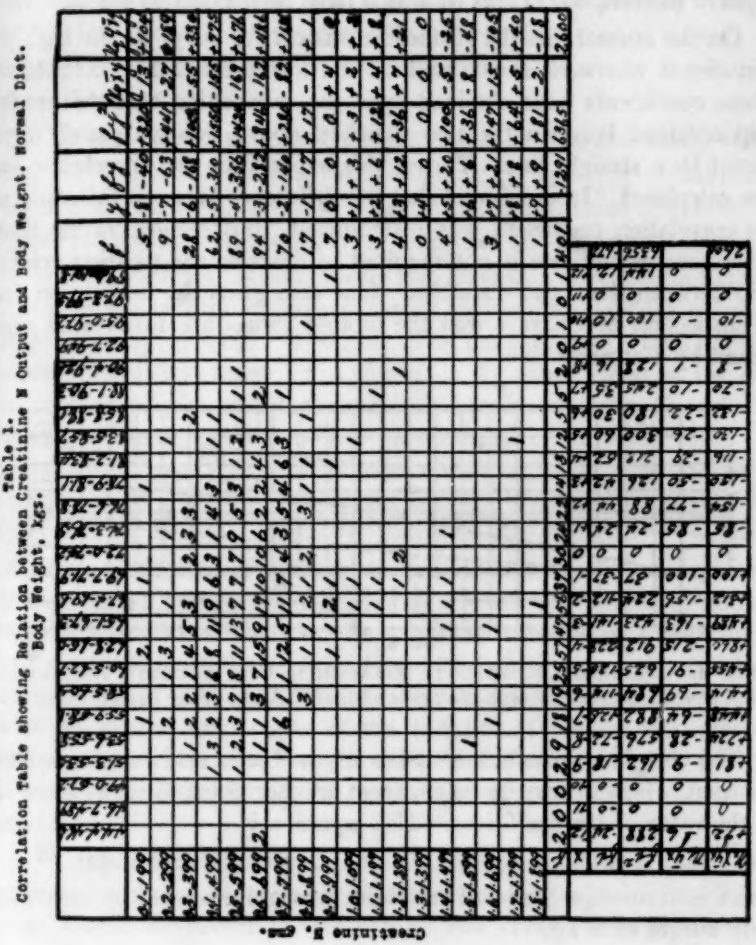
Table 1.
Correlation Table showing Relation between Creatinine N Output and Body Weight. Normal Diet.
Body Weight, Kgs.
Creatinine N, Gms.

[5] Folin, O., *J. Biol. Chem.*, *17*, 469 (1914).

The data collected from the large group of medical students are given in Table 1. The results show, for example, that 62 men excreted practically the same amount of creatinine nitrogen with body weights varying from 51 to 85 kgs. Again, 89 men excreted practically the same amount with body weights varying from 51 to 90 kgs. The correlation coefficient between the excretion of creatinine nitrogen and body weight on the normal protein diet was calculated by the product moment method, the details of which have been given by Rietz.[6]

On the normal diet the coefficient was $0.13 \pm 0.03$; on the high protein diet it was $0.16 \pm 0.04$ and on the low protein diet, $0.16 \pm 0.03$. These coefficients were obtained upon the supposition that the relationship obtained between the two variables above was adequately represented by a straight line. To test this supposition the correlation ratio was calculated. It was found that the difference between this ratio and the correlation coefficient was insignificant, thus demonstrating that a curved regression line is not required to describe the existing relationship between these two variables. One also gains the impression from an inspection of Chart 1 that the plotted values are fairly well represented by a straight line.

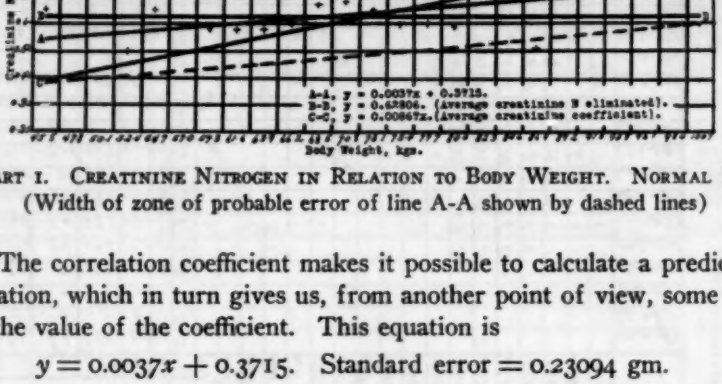
A-A, y = 0.0037x + 0.3715.
B-B, y = 0.62806. (Average creatinine N eliminated).
C-C, y = 0.00867x. (Average creatinine coefficient).
Body Weight, kgs.

CHART 1. CREATININE NITROGEN IN RELATION TO BODY WEIGHT. NORMAL DIET. (Width of zone of probable error of line A-A shown by dashed lines)

The correlation coefficient makes it possible to calculate a prediction equation, which in turn gives us, from another point of view, some idea of the value of the coefficient. This equation is

$$y = 0.0037x + 0.3715. \quad \text{Standard error} = 0.23094 \text{ gm.}$$

where $y$ = average grams of creatinine nitrogen excreted by men with a body weight of $x$ kg.

[6] Rietz, H. L., Handbook of Mathematical Statistics, Houghton, Mifflin Co., *New York, 120* (1924).

If we now substitute our lowest and highest weight groups (45.5 and 100.7 kgs., respectively, given in Table 1) for $x$ in our prediction equation, we will get the center points (0.54 and 0.74 gm.) of the first and last arrays. By connecting these points we get line *A-A* of Chart 1 for the average relationship of creatinine nitrogen on body weight. The "+" values on the chart represent the average creatinine nitrogen excreted by those individuals falling within the corresponding weight groups. The probable error of the line is equal to $0.23 \times 0.6745$, or 0.16 gm. The width of zone of probable error is shown by the dashed lines on the chart.

Let us now see if we can apply our equation to some actual tests, taking, for example, 100 men each weighing 80 kgs. By substituting 80 for $x$ in the above equation we get 0.67 gm., the amount of creatinine nitrogen each would theoretically be expected to eliminate. Actually each person would not excrete exactly this amount. Assuming a normal distribution, the creatinine nitrogen output of 50 men would fall between a range indicated by $0.67 \pm 0.16$ gm. The remaining 50 would excrete amounts without this range ($\pm 0.16$ gm.). By actual count of the 401 cases, 271, or 68 per cent, came within the indicated zone of probable error of the line *A-A*, while 128, or 32 per cent, fell outside. Since the width of zone of probable error is so great it is seen that if we are given the weight of an individual we cannot calculate with much accuracy his daily creatinine nitrogen output by means of our equation.

Another method of estimating the amount excreted by an unknown individual would be to take the average 24-hour output of creatinine nitrogen. Line *B-B* of Chart 1 represents this value for the large number of students studied, and was found to be 0.63 gm., the standard error of which is 0.23 gm. The standard error is equal to the square root of the sum of the squares of the deviations from the line, divided by the number. It is seen that the error in this case is slightly greater than that of the best fitting line above and gives a poorer fit to the observations.

Suppose we now take the case where the assumption is made that the creatinine nitrogen output is proportional to the body weight. What relation would we obtain in this case? The creatinine coefficients in terms of creatinine nitrogen were calculated. The frequency distribution is shown in Chart 2. The ranges are from 6 to 11 mg. creatinine nitrogen per kilo body weight and are practically the same limits as

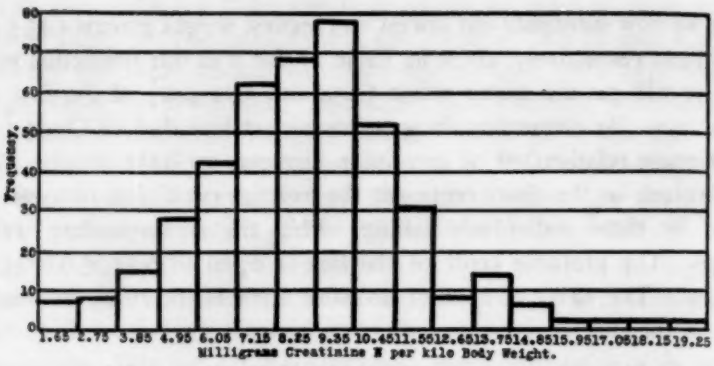


CHART 2. HISTOGRAM OF CREATININE COEFFICIENTS

originally given by Shaffer. The average creatinine nitrogen coefficient was calculated to be 8.67 mg. per kilo body weight. Line *C-C* of Chart 1 is based on this average coefficient. Hence,

$$y = 0.00867x. \quad \text{Standard error} = 0.24 \text{ gm.}$$

It is seen that the standard error of this line is slightly greater than that of the other two lines above and thus gives, from a mathematical point of view, the poorest fit of all to the observations. As the standard error increases the width of zone of probable error becomes greater and the accuracy of any prediction which may be made from corresponding equations becomes less.

Thus it is seen that the predictions made by any of the above methods are of little or no value, and one seems to be justified in drawing the conclusion that the excretion of creatinine nitrogen is not very closely influenced by the body weight.

*Writer's Analyses.* In order to remove any objection to the medical student analyses of creatinine nitrogen, the weight and height of 112 students were taken and the creatinine determinations made by the writer.[7] This group was instructed to eat no meat for 3 days, on the last of which the specimen was to be collected. A correlation coefficient of $0.09 \pm 0.06$ was obtained, which again shows little or no relation between body weight and creatinine nitrogen elimination in the normal individual.

[7] Dr. Alfred Chanutin, on leave of absence from the University of Virginia, was a guest in the laboratory during this part of the study and made the colorimetric comparisons of creatinine, for which the writer's best thanks are due.

*Observations taken from the Literature.* It was next decided to obtain all the cases from the literature where the body weight and corresponding creatinine output were given. We were able to find 94 cases for normal men and 98 for normal women. Where the creatinine was given it was calculated to creatinine nitrogen by the writer. All of the subjects were stated to have been on a creatine-creatinine-free diet for several days before the determinations were made.

The data for men gave a correlation coefficient of $0.24 \pm 0.07$, while that for women was $0.26 \pm 0.06$. Since these are small and of the same order of magnitude as those reported above they are considered as suggestive only, and again point to the fact that there is little or no relation between the two variables under discussion.

*Surface Area.* The surface area of 288 students was calculated by the formula of DuBois,[8]

$$S = W^{0.425} \times H^{0.725} \times 71.84,$$

where $S$ is the surface area in sq. m., $W$, the weight in kgs., and $H$, the height in cms. A correlation coefficient of $0.06 \pm 0.04$ was obtained between creatinine nitrogen output and surface area, thus showing practically no relation between these two variables.

Since basal metabolism is proportional to surface area, it is probable that there is also no relation between basal metabolism and creatinine output. Benedict[9] discussed the question as to whether the creatinine output should be regarded as an index of the change in the mass of active tissue, but stated that his results showed no obvious relation between the total standard metabolism and creatinine elimination. Working with normal individuals, Palmer, Means and Gamble[10] obtained similar results.

*The Two-thirds Power of the Body Weight.* The correlation coefficient between this variable and creatinine nitrogen elimination was exactly the same as that obtained above for the body weight.

*Height.* No correlation was obtained between the height and the creatinine elimination. Benedict and Myers[11] could find no relation between these two variables in 26 cases of insane women.

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[8] DuBois, E. F., and DuBois, D., *Arch. Int. Med.*, *17*, 863 (1916).

[9] Benedict, F. G., Carnegie Inst. Wash. Reports (1907-15), quoted from Cathcart, E. P., The Physiology of Protein Metabolism, Longmans, Green and Co., 117 (1921).

[10] Palmer, W. W., Means, J. H., and Gamble, J. L., *J. Biol. Chem.*, *19*, 239 (1914).

[11] Benedict, F. G., and Myers, V. C., *Amer. J. Physiol.*, *18*, 377 (1907).

In Table 2 will be found all the correlation coefficients obtained in the above studies.

TABLE 2

*Correlation Coefficients of Creatinine Nitrogen Output with Several Body Measurements. Normal Diet.*

| VARIABLE | NO. OF CASES | r | r / P.E. |
|---|---|---|---|
| Creatinine N and Body Weight | 401 | 0.13 ± 0.03 | 4.3 |
| Creatinine N and Body Weight $^{2/3}$ | 401 | 0.13 ± 0.03 | 4.3 |
| Creatinine N and Surface Area | 288 | 0.06 ± 0.04 | 1.5 |
| Creatinine N and Body Weight | 122 | 0.09 ± 0.06 | 1.5 |
| Creatinine N and Height | 122 | 0.00 ± 0.06 | 0.0 |
| Creatinine N and Body Weight (men)* | 94 | 0.24 ± 0.07 | 3.4 |
| Creatinine N and Body Weight (women)* | 98 | 0.26 ± 0.06 | 4.3 |

* Observations taken from the literature.

In comparison with the above coefficients those obtained between the excretion of creatinine nitrogen and several other forms of nitrogen in the urine of the students were calculated. They were as follows:

Creatinine N with Total N..... 0.10 ± 0.03
Creatinine N with Urea N..... 0.03 ± 0.04
Creatinine N with Ammonia N.... 0.16 ± 0.03

It is well known that the excretion of creatinine nitrogen is independent of the excretion of these forms of nitrogen on a normal diet. These small coefficients confirm this view, and are of the same order of magnitude as those obtained above. This is further evidence of the lack of relationship between creatinine nitrogen and body weight.

## DISCUSSION

The small coefficients obtained in this study between the above variables are considered to have no significance within themselves. In this connection White [12] has calculated some 4000 correlation coefficients between different constituents of 100 pathological urines and stated that a coefficient of less than 0.4 did not mean very much, while one below 0.3 had no significance within itself. It might be borne in mind in this connection that a correlation coefficient of 1 between two variables is considered perfect by statisticians.

[12] White, C. P., *J. Path. and Bacteriol., 28,* 211 (1925).

Some investigators hold the view that a much better relation than the body-weight-creatinine-excretion would be muscle-mass-creatinine-excretion, due no doubt to the fact that about 98 per cent of body creatine is contained in the muscles. But even so there is experimental evidence to show that such is not the case. Garot,[13] in a very complete study of creatine-creatinine excretion in infants, concluded that the creatinine excretion was not proportional to muscular mass. Terroine and Garot[14] studied the excretion of creatine and creatinine in various warm blooded animals with heat productions of very different intensities. They found that the daily creatinine output of the rat was 60 mg. per kilo body weight as compared to 16 mg. per kilo for the horse. It was also observed that the creatinine excretion per kilo presented very great differences among these warm blooded animals. From these observations they concluded that the excretion of creatinine constituted in no way a measure of the muscular mass.

It was also observed in the studies reported in this paper that the average creatinine output of the large group of students on the normal and high protein diets was practically the same. This was no doubt due to the fact that the latter diet did not contain *enough* protein to accelerate the creatinine output. On the other hand when the diet low in protein was eaten the average creatinine excretion was 1.67 gm. daily as compared to 1.78 gm. on the high protein diet, or a decrease of 6.5 per cent. This is further evidence of the effect of the level of protein metabolism on the excretion of creatinine in the urine. Bollman[15] has also published evidence to show that the level of protein metabolism is of great influence upon the creatine-creatinine transformation in the dog.

Since the present statistical study was completed much experimental evidence has been obtained in this laboratory by Beard and Barnes[16] to show that, under definite experimental conditions in the rat and man, the chief factor determining the origin of creatine in the muscles and the excretion of creatinine in the urine is the intensity of the protein or amino acid metabolism per unit of time. This view is considered as a direct confirmation of much evidence in the literature concerning this point.

[13] Garot, L., *Revue Française de Pédiatrie, 6,* 265 (1930).
[14] Terroine, E. F., and Garot, L., *Arch. Internat. de Physiol., 27,* 69 (1926).
[15] Bollman, J. L., *J. Biol. Chem., 85,* 169 (1929-30).
[16] Beard, H. H., and Barnes, B. O., *J. Biol. Chem., 94,* 49 (1931).

What then is the physiological relation between the body weight and the daily creatinine output? The above evidence would tend to show that the body weight should be considered as a secondary factor and the level of protein metabolism the primary factor, in this connection. Let us suppose for instance that a large individual does happen to excrete more creatinine than a smaller one. The former would also very likely eat more protein in his larger food intake than the latter, thus accounting for his somewhat greater creatinine coefficient. On the other hand if the smaller man should eat a very large amount of protein for lunch on a given day his creatinine excretion on the following day would even rise above that of the larger man, provided this individual continued to eat the same amount of protein. This fact was very clearly shown by Beard and Barnes.

It now remains to discuss the endogenous origin of creatine and creatinine in the light of the above studies. The chief evidence that we possess for the endogenous origin of these substances is derived from the following three considerations: (1) the constancy of the muscle creatine of any given species of animal, (2) the constancy of the daily creatinine output on a normal diet, and (3) the constancy of the daily creatinine output in starvation. (1) would be explained by a uniform protein intake. (2) would also be largely influenced by the protein intake as the following evidence in Table 3 (which gives the average distribution of nitrogen in the urine of the 401 medical students, ranging in weight from 51 to 101 kgs., each eating an average of 75 gm. protein daily) will show.

TABLE 3

| SUBSTANCE | AMOUNT *gm.* | NITROGEN CONTENT *gm.* | PER CENT OF TOTAL NITROGEN |
|---|---|---|---|
| Total Nitrogen | .... | 11.16 | .... |
| Urea | 20.38 | 9.51 | 85.21 |
| Ammonia | 0.66 | 0.54 | 4.83 |
| Uric Acid | 0.57 | 0.19 | 1.70 |
| Creatinine | 1.70 | 0.63 | 5.64 |
| Undetermined Nitrogen (by difference) | .... | 0.29 | 2.62 |

These results show definitely that a uniform intake of protein will result in a uniform excretion and distribution of nitrogen in the urine which is independent of such factors as the endogenous metabolism,

body weight, muscle mass, etc. In regard to (3) one cannot consider complete starvation as a physiological process. A constant excretion of creatinine here simply represents the rate of the creatine-creatinine transformation in the body in the complete absence of food. It is also well known that after all carbohydrate has been oxidized in fasting the daily excretion of total nitrogen (which also means the daily excretion of urea nitrogen) will be about 10 or 11 gm. until about the fifteenth day. It will then fall to about 7 or 8 gm. daily (DuBois[17]). In these two periods we have a more or less constant excretion of these forms of endogenous nitrogen, the amount of which depends upon the rate of tissue destruction. Yet no one believes that the total and urea nitrogen in the urine, when a normal diet is ingested, are derived from the endogenous metabolism. On the other hand it is well known that they represent the metabolism of the exogenous protein of the diet. The writer believes that the same is true, to a somewhat lesser extent, of creatine and creatinine metabolism.

## SUMMARY AND CONCLUSIONS

The correlation coefficients between the excretion of creatinine nitrogen and several body measurements of two large groups of male medical students between the ages of 19 and 30 years with body weights varying from 50 to 100 kg., and the correlation coefficients of these two variables from data (of a large group of men and women) taken from the literature, were calculated. All of the coefficients obtained were below 0.3 and were therefore considered to indicate such a slight degree of relationship that they would have little if any significance from a physiological point of view.

On the basis of the data studied, it is shown by mathematical and graphical methods that there is little if any relationship between the excretion of creatinine nitrogen and the body weight. The relationship which does exist is too small to make possible a very helpful prediction equation, but the one obtained by using the correlation coefficient was the best possible from the point of view of least squares. The assumption that the creatinine nitrogen output is proportional to the body weight gives the poorest result, judged from the point of view of the goodness of fit of the resulting line to the actual observations.

[17] DuBois, E. F., Basal Metabolism in Health and Disease, Lea and Febiger, *Philadelphia*, 2nd. ed., 1927, p. 212.

Little or no relationship was found between creatinine excretion and surface area (and hence also basal metabolism), two-thirds power of the body weight, and the height, of the students studied. The average creatinine output on the diet low in protein was 6.5 per cent below that excreted on a diet rich in protein.

The above data afford additional evidence for the writer's view that both creatine and creatinine are products of an exogenous, rather than an endogenous, protein metabolism.

I wish to acknowledge my indebtedness to Dr. G. E. Harmon of the Department of Hygiene and Bacteriology of Western Reserve University for suggestions concerning the statistical methods used and for assistance in making the necessary calculations.

# CONTRACEPTION AND FERTILITY IN 2,000 WOMEN[1]

BY RAYMOND PEARL

## THE PROBLEM

Discussion of the more important problems of population suffers at the present time from a plethora of opinion and argumentation, and from a dearth of exact, objective, scientific observations. The principal reason for this state of affairs is the great difficulty inherent in the nature of the case, so far as concerns obtaining reliable and pertinent data, on an adequate statistical scale, regarding the reproduction of man. Official census and registration statistics furnish only a minimum of information useful for any penetrating analysis of the matter. There are, to be sure, considerable differences between different countries in the diversity and pertinence of their natality statistics. But even those having the better systems, from the point of view of the student of population problems—notably Holland and Sweden—leave much to be desired. Generally speaking only the grossest and crudest facts are officially recorded and tabulated, such as the total population by age, sex, color, etc., or the crude birth rate, uncorrected and unstandardized, etc.

It is common and undisputed knowledge that birth rates, however measured, have generally and with but few exceptions been falling for a considerable time past in most countries keeping such records. This is an obviously important phenomenon. But what the student of population wants to know is something about the causal factors—biological, social, economic, and/or other—lying behind the phenomenon. It is true that there can be, and has been, some definite progress made towards an understanding of the part played by some of these factors, through a study of the meager official data furnished by census and registration offices referred to above. Without exhausting the cases,

[1] From the Department of Biology of the School of Hygiene and Public Health, Johns Hopkins University; and the Division of Research of the Milbank Memorial Fund. The substance of this paper, which is preliminary in character, as explained in the text *infra*, was presented at the Annual Meeting of the Milbank Memorial Fund in New York on March 16, 1932, and to the Society of Hygiene in Baltimore on March 23, 1932.

there may be mentioned here, as examples of what can be made out of official statistical reports alone, such studies as those of Körösi,[2] Heron,[3] Yule,[4] Hill,[5] Elderton,[6] Pearl,[7] Dublin and Lotka,[8] Lotka,[9] Wicksell,[10] and Sanders.[11] But in most such cases, and others that might be cited, the investigators have been hampered and limited by the paucity and lack of penetrating relevance of the available data. This has led to the development of special studies of various aspects of the problems of human fertility, involving the collection of *ad hoc* data from diverse sources and in different ways. Such studies have certain definite statistical characteristics. To begin with, they rely in all cases upon the sampling method rather than that of enumeration or registration of the entire population. Further, they usually deal with differentiated samples: that is, with groups of people who in one way or another fall into special classes of the population. Being generally based upon non-official statistics their data are naturally looked upon with greater

[2] Körösi, J. An estimate of the degree of legitimate natality drawn from observations made at Budapest. *Jour. Roy. Stat. Soc.*, Vol. 57, pp. 690-702, 1894.

[3] Heron, D. On the relation of fertility in man to social status and on the changes in this relation that have taken place during the last fifty years. *Drapers' Company Research Mem., Studies in National Deterioration*, I. *London, (Dulau)*, 1906.

[4] Yule, G. U. On the changes in the marriage and birth-rates in England and Wales during the past half-century; with an inquiry as to their probable causes. *Jour. Roy. Stat. Soc.*, Vol. 69, pp. 88-132, 1906: The growth of population and the factors which control it. *Jour. Roy. Stat. Soc.*, Vol. 88, pp. 1-58, 1925.

[5] Hill, J. A. Comparative fecundity of women of native and foreign parentage in the United States. *Publ. Amer. Stat. Assoc.*, Vol. 13, pp. 583-604, 1913.

[6] Elderton, E. M. Report on the English birth rate. Part I. England, north of the Humber. *Eugenics Lab. Mem.*, 19 and 20, Cambridge Univ, Press, 1914, pp. viii + 246.

[7] Pearl, R. The Biology of Population Growth. *New York* (Alfred A. Knopf), 1925. Pp. xiv + 260: Differential fertility. *Quart. Rev. Biol.*, Vol. 2, pp. 102-118, 1927.

[8] Dublin, L. I., and A. J. Lotka. On the true rate of natural increase as exemplified by the population of the United States, 1920. *Jour. Amer. Stat. Assoc.*, Vol. 20, pp. 305-339, 1925.

[9] Lotka, A. J. The spread of generations. *Human Biology*, Vol. 1, pp. 305-320, 1929: The structure of a growing population. *Ibid.*, Vol. 3, pp. 459-493, 1931.

[10] Wicksell, S. D. Nuptiality, fertility, and reproductivity. *Skandinavisk Aktuarietidskrift*, 1931, pp. 125-157.

[11] Sanders, J. The Declining Birth Rate in Rotterdam. A Statistical Analysis of the Drop in the Number of Children in 24,664 Rotterdam Families during the last 50 Years. *The Hague* (M. Nijhoff), 1931. Pp. xi + 179.

suspicion. They also inevitably receive a certain amount of irresponsible criticism from those whose prejudices run counter to some or all of whatever conclusions the author may reach. If the data are, in fact, sound such irresponsible criticism is without significance. Of more importance is the fact that in such special investigations the numbers involved are often smaller than is desirable for the reaching of sound conclusions. But in spite of some statistical defects and disabilities in these special studies they have materially advanced knowledge and broadened the point of view regarding some of the basic problems of human population here under discussion. If well conceived and carried out they have the enormous advantage of attacking more precisely formulated, more penetrating, and more significant questions, than can usually be attacked with only official government statistics as material. Into the category under discussion may be put, as examples and again without exhausting the available cases, such studies as those of Hewes,[12] Cattell,[13] Johnson and Stutzmann,[14] Brown, Greenwood, and Wood,[15] Savorgnan,[16] Spiegelberg,[17] Fürst and Lenz,[18] Phillips,[19] Davis,[20] Notestein,[21] Sydenstricker,[22,23] and Boldrini.[24]

[12] Hewes, A. Marital and occupational statistics of graduates of Mount Holyoke College. *Publ. Amer. Stat. Assoc.*, Vol. 12, pp. 771-797, 1911.

[13] Cattell, J. McK. Families of American men of science. *Pop. Sci. Mo.*, Vol. 86, pp. 504-515, 1915; *Sci. Mo.*, Vol. 4, pp. 248-262; Vol. 5, pp. 368-377, 1917.

[14] Johnson, R. H., and B. Stutzmann. Wellesley's birth rate. *Jour. Heredity*, Vol. 6, pp. 250-253, 1915.

[15] Brown, J. W., M. Greenwood, and F. Wood. The fertility of the English middle classes. A statistical study. *Eugenics Rev.*, Vol. 12, pp. 158-211, 1920.

[16] Savorgnan, F. La fecondità della aristocrazie; le case mediazzate della Germania. *Metron*, Vol. 3, pp. 439-468, 1923.

[17] Spiegelberg, R. Kinderreichtum und sozialer Aufstieg bei Kruppschen Arbeitern. *Arch. Rass.- u. Gesellsch.-Biol.*, Bd. 16, S. 267-275, 1924.

[18] Fürst, Th., and F. Lenz. Ein Beitrag zur Frage der Fortpflanzung verschiedener begabter Familien. *Arch. Rass.- u. Gesellsch.-Biol.*, Bd. 17, S. 353-359, 1926.

[19] Phillips, J. C. Further studies of the Harvard birth-rate—classes 1891-1900. *Harvard Graduates' Mag.*, March, 1926, pp. (of reprint) 1-12.

[20] Davis, Katherine B. Factors in the Sex Life of Twenty-two Hundred Women. *New York* (Harper and Bros.), 1929. Pp. xx + 430.

[21] Notestein, F. W. The decrease in size of families from 1890 to 1910. *Quart. Bull. Milbank Mem. Fund*, Vol. 9, pp. 181-188, 1931.

[22] Sydenstricker, E. A study of the fertility of native white women in a rural area of western New York. *Quart. Bull., Milbank Mem. Fund*, Vol. 10, pp. 17-32, 1932.

[23] Sydenstricker, E., and F. W. Notestein. Differential fertility according to social class. A study of 69,620 native white married women under 45 years of age

It is generally agreed by all persons competent to have an opinion on the subject that the practice of contraception (birth control) is a factor at least potentially capable of influencing the birth rate. There is no such widespread agreement as to how significant a factor it has been, and is now, in causing the decline of birth rates. Some persons think it is the only factor worthy of serious consideration. Others are of the opinion that it has played no significant rôle, up to the present time, in the movements of the birth rates of large population aggregates considered as wholes. Still others hold an intermediate position somewhere between these extremes.

There are several immediately apparent reasons for this diversity of opinion. In the first place no one really *knows* how extensively contraceptive measures of any sort are actually used by the general population of any country, taken as a whole. Secondly, for emotional or propagandist reasons, exaggerated inferences, in one direction or the other, are drawn from meager experience, statistically considered. The leaders of the birth control movement, for example, argue that information on contraceptive technique should be widely disseminated, because relatively few know anything about it. On the other hand those opposed to birth control argue that already information on the subject is so widespread, and the technique is put into practice so generally, as even to endanger the continued existence of some of the groups standing highest in the scale of civilization. Both sides to this controversy are in possession of the same objective evidence. One side knows nothing that the other does not know relating to what may be euphemistically called the "facts" in the case. What could indicate more clearly than this situation the need for more critical objective evidence, and less chatter about birth control, either for or against?

In the third place, there exists almost nothing in the way of critical, objective, unbiassed evaluation of the effectiveness of any or all contraceptive techniques, as actually practised in the population. If a few special studies such as those of Davis,[25] Brown, Greenwood, and

based upon the United States Census returns of 1910. *Jour. Amer. Stat. Assoc.*, Vol. 25, pp. 9-32, 1930.

[24] Boldrini, M. La fertilità dei biotipi. Saggio di demografia costituzionalistica. *Milano* (Società editrice "Vita e Pensiero"), 1931. Pp. xiii + 238.

[25] Davis, K. B. *Loc. cit.*, footnote 20.

Wood,[26] and Dickinson and Beam [27] are excepted, nearly all the so-called evidence as to the effectiveness of contraceptive practices comes from persons or organizations interested in birth control propaganda (for recent examples see Cooper [28] and Stopes [29]). But it is a sound human instinct to look somewhat askance at too obviously *ex parte* testimony, and to attach but little weight to any protestation of honesty or nobility of purpose which may accompany it. The major difficulty in the matter under discussion appears to be that there is considerable confusion of thought about the difference between the potentiality and the actuality of effectiveness of contraceptives. It is dubious logic to reason from the fact that a highly intelligent woman, thoroughly trained in biology in a university, and obsessed with an overwhelming fear of unwanted pregnancy is able to use a particular contraceptive device with unfailing success, to the conclusion that this contraceptive device is, or will be, equally effective as actually used by all women who resort to it in the general population. Nor can it be safely inferred from the same premise that birth control is a major factor in causing the decline in the birth rate.

What has been said may perhaps be taken to have set with sufficient clarity, even though briefly, the background of the two problems with which this present investigation is concerned. These problems may be stated concisely as follows:

*1. To what extent statistically is any sort of contraceptive technique, device, or habit actually practised in a defined sample of the population of the United States at the present time?*

*2. What is the quantitative effectiveness exhibited by the various contraceptive techniques, considered both separately and all together, in reducing the relative frequency of pregnancy, as these techniques are actually used in a defined sample of the population of the United States at the present time?*

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[26] Brown, Greenwood, and Wood. *Loc. cit.*, footnote 15.

[27] Dickinson, R. L., and Lura Beam. A Thousand Marriages. A Medical Study of Sex Adjustment. *Baltimore* (Williams and Wilkins), 1931. Pp. xxv + 482.

[28] Cooper, J. F. Technique of Contraception. The Principles and Practice of Anti-conceptional Methods. *New York* (Day-Nichols) 1928. Pp. xvi + 271.

[29] Stopes, Marie C. Preliminary notes on various technical aspects of the control of conception. Based on the analysed data from ten thousand cases attending the Mothers' Clinic London. *London* (Mothers' Clinic for Contraceptive Birth Control), 1930. Pp. 46.

These two questions make plain the purpose of the study. It is a modest effort to get some direct, objective, quantitative evidence, as precise as possible, and with every critical safeguard that we have been able to think of and put into practice to insure its accuracy and dependability, to help towards reaching a sounder judgment than is now possible about the real influence of birth control upon the movement of population. Because of the great expense in time, labor and money involved in collecting data of the accuracy and manifoldness requisite for critical work in this field it is obvious that the numbers cannot be expected to amount to any grand statistical heights. We shall have to be content with modest, but hopefully adequate samples. More will be said on this point in a later section. But it is hoped and believed that even with this and other limitations and disabilities which will presently appear, the investigation when completed will mark some real progress in an extremely difficult field. When so little is definitely known as is the case here, even the most modest contribution seems bound to have some usefulness, if only to show how the next attack on the problem may be more intelligently directed.

## THE PLAN AND METHODS OF THE INVESTIGATION

*History.* This study had its inception in 1924. The general idea and plan were developed at that time in essentially their present form. A blank record was drawn up, and the late Dr. J. Whitridge Williams, professor of obstetrics in the School of Medicine of the Johns Hopkins University, made arrangements to have the plan put into operation in the obstetric wards of the Johns Hopkins Hospital. A few records were collected from that source at that time, but only a few. The plan languished and eventually died, chiefly because everyone involved in it was too fully occupied with other matters. Particularly the residents and internes on the service, upon whom devolved the labor of getting the data from the patients, were too busy to do it except in their spare time, and no funds were available to pay them anything for their trouble. The whole project thus lay fallow until the autumn of 1929. During this period general interest in the problems of population had greatly developed. A World Conference on population had been held;[30] an

[30] *Cf.*, Proceedings of the World Population Conference . . . . Geneva . . . 1927. Edited by Margaret Sanger. *London* (Arnold) 1927. Pp. 383.

International Union for the Scientific Investigation of Population Problems had been formed and put into operation;[81] various university departments and other institutions had embarked upon the active promotion and prosecution of research in the field. Among the latter was the Research Division of the Milbank Memorial Fund, which had most generously aided the International Union in its work. In 1929 an interest was expressed by Mr. Edgar Sydenstricker and Mr. John H. Kingsbury of the Milbank Memorial Fund to have the project continued on an adequate scale. This was made possible by a substantial grant for the year 1931, which was continued on a somewhat larger scale for the year 1932. I wish to express here my deep appreciation and gratitude for this aid.

With sufficient funds available to carry on the work the initial plans were critically reviewed and revised. At my request the following persons agreed to serve as an Advisory Committee in connection with the project: Dr. Carl G. Hartman, Dr. John R. Miner, Prof. Lowell J. Reed, Mr. Edgar Sydenstricker, and the late Dr. J. Whitridge Williams, with the writer as chairman. I am very grateful to this Committee for help in getting the project soundly organized. The staff began work on July 1, 1931 and the inflow of record cards started in August.

*Plan.* The plan of the investigation, in briefest outline, was to have filled out a simple but rather comprehensive history card for each woman delivered of a baby in the obstetric service of some hospital located in or near a large city east of the Mississippi River. The history carries basically two broad categories of information: first, the entire reproductive history of the woman, and, second, an account of her use of contraceptives. The history card actually used—5 x 7 inches in size—is shown in facsimile in Figs. 1 and 2.

*Instructions.* The details of the plan may best be made clear by the detailed, written instructions to the coöperative workers, which in their present revised form are as follows:

> The purpose of the investigation is to gather a mass of unbiassed objective information relative to two primary problems, viz. (1) The extent to which contraceptive (birth control) practices are employed by women in a large sample of the American urban population; and (2) the reproductive histories of this group of normal American women.

[81] *Cf.*, Bulletin of the International Union for the Scientific Investigation of Population Problems, Vols. I and II, 1930-31, *passim.*

HOSPITAL
OBST. NO.

DATE OF DELIVERY

LEGIT. OR ILLEGIT.

DO NOT WRITE IN THIS SPACE

| COLOR | RACE STOCK | RELIGION | HAS PATIENT ANY GYNECOLOGICAL DISEASE? IF SO SPECIFY. |
|---|---|---|---|
| W. C. | | | |

**REPRODUCTIVE HISTORY**
INCLUDING PRESENT ADMISSION

| PREGNANCY | YEAR | RESULT |
|---|---|---|
| 1 | | L. S. M. T. O. |
| 2 | | L. S. M. T. O. |
| 3 | | L. S. M. T. O. |
| 4 | | L. S. M. T. O. |
| 5 | | L. S. M. T. O. |
| 6 | | L. S. M. T. O. |
| 7 | | L. S. M. T. O. |
| 8 | | L. S. M. T. O. |
| 9 | | L. S. M. T. O. |
| 10 | | L. S. M. T. O. |
| 11 | | L. S. M. T. O. |
| 12 | | L. S. M. T. O. |
| 13 | | L. S. M. T. O. |
| 14 | | L. S. M. T. O. |
| 15 | | L. S. M. T. O. |

L=LIVE BABY. S=STILL BORN.
M=SPONTANEOUS MISCARRIAGE
T=THERAPEUTIC ABORTION.
O=OTHER ABORTION

HAS PATIENT EVER USED ANY METHOD FOR PREVENTION OF CONCEPTION? YES. NO.
(FILL IN DETAILS ON OTHER SIDE OF CARD)

DATE OF BIRTH OF PATIENT?
DATE OF BIRTH OF HUSBAND?
DATE OF MARRIAGE?

WARD, PAY, OR PART PAY PATIENT

OCCUPATION OF HUSBAND?

EDUCATION OF PATIENT { ILLITERATE, ELEMENTARY SCHOOL, HIGH SCHOOL, COLLEGE

ECONOMIC POSITION { VERY POOR, POOR, MODERATE CIRCUMSTANCES, WELL-TO-DO, RICH

HAS PATIENT EVER HAD SELF-INDUCED ABORTION? YES. NO.
HAS PATIENT EVER HAD ABORTION INDUCED BY SOMEONE ELSE? YES. NO.
(IF ANSWER IS YES IN EITHER CASE, DESCRIBE METHOD USED)

NOTES:

THIS CARD WAS FILLED OUT BY:

OVER

FIG. 1. HISTORY CARD USED IN THE INVESTIGATION. OBVERSE

METHODS OF CONTRACEPTION USED

O=OTHER ABORTION

FILLED OUT BY:

OVER

FIG. 1. HISTORY CARD USED IN THE INVESTIGATION. OBVERSE

## METHODS OF CONTRACEPTION USED

(TO BE FILLED IN WITH AS MUCH DETAIL AS POSSIBLE)

| METHOD | CHECK USE | HOW LONG WAS EACH OF SPECIFIED METHODS PRACTISED? | WHAT IS PATIENT'S OPINION AS TO EFFECTIVENESS OF METHODS SHE HAS USED? |
|---|---|---|---|
| COITUS INTERRUPTUS (WITHDRAWAL) | | | |
| CONDOM { RUBBER / SKIN } | | | |
| PESSARY ALONE | | | |
| PESSARY WITH MEDICATED JELLY | | | |
| PESSARY WITH DOUCHE | | | |
| MEDICATED VAGINAL SUPPOSITORIES OR JELLIES* | | | |
| DOUCHE ALONE—WATER | | | |
| DOUCHE ALONE—MEDICATED* | | | |
| INTRA-UTERINE MECHANICAL DEVICE* | | | |
| "SAFE PERIOD" (ABSTINENCE DURING PART OF MONTH) | | | |
| ANY OTHER METHOD* | | | |

* SPECIFY KIND HERE:

DO NOT WRITE IN THIS SPACE

OVER

FIG. 2. HISTORY CARD USED IN THE INVESTIGATION. REVERSE

The plan for accomplishing this purpose, in which you are asked to coöperate, involves the following elements:

1. The regular and systematic filling out of a simple card form for each and every woman delivered in the obstetrical service of the hospital with which you are connected.

2. These cards will be furnished by the Department of Biology. They will be filled out by a designated member of the staff (resident, interne, or other but *not* a nurse).[23] For this service a fee of five cents per card will be paid.

3. The accumulated cards from the previous week properly filled in will be mailed each Monday morning, in self-addressed envelopes which will be furnished for the purpose. You will be reimbursed for the postage.

4. The data will be analyzed and tabulated in the Department of Biology, and from time to time progress reports upon the investigation will be issued.

*Primary essentials* to a successful and significant outcome to the investigation are:

1. Painstaking accuracy in getting the information and putting it on the cards.

2. Absence of selection of cases. *Every* case delivered in the hospital should be included.

3. Systematic and prompt return of the cards to the Department of Biology.

The Supervising Field Worker will explain the details of the plan and help you to get started. The work began with the leading hospitals in Baltimore, and has gradually extended to other cities in the eastern part of the United States.

## INSTRUCTIONS FOR FILLING OUT THE CARDS

### A. GENERAL INSTRUCTIONS

a. The records on the cards should always be made in ink.

b. Please write legibly. In particular be careful to make all *figures* perfectly legible.

c. Whenever *dates* are called for in the record *do not abbreviate,* but write them out in full, as, for example, March 27, 1930. Such a record for the date as *3/27/30 is not acceptable.*

d. Before starting the work read *all* the instructions over carefully and thoughtfully, comparing them at each point with the card.

### B. SPECIAL INSTRUCTIONS

1. HOSPITAL. The *name* of the hospital will be filled in here, either in writing or by means of a rubber stamp.

---

[23] The idea of this restriction was that the data should always be taken by medically trained persons, having the confidence of the patient on the one hand, and the technical knowledge and training on the other hand, to ensure the scientific accuracy and completeness of the records. As a matter of fact as the work progressed it has been necessary in a few cases to employ graduate nurses for the actual record making, working under the supervision of a staff member. In each such case they have done the work faithfully and intelligently.

2. OBST. NO. This means the obstetrical case or service number of the particular patient to whom the card applies, in the series of case histories of the particular hospital where the record is made. It should be filled in by the worker. It might be, for example, No. 18,476 of the case histories in the Obstetrical Service of the Johns Hopkins Hospital. The purpose of recording it on the card is to provide for the contingency that it might be necessary for us at some time to look up again the original hospital history.

3. DATE OF DELIVERY. Write out in full, as August 30, 1931, the date when the patient to whom the card applies was delivered of her baby (or alternatively the date when her pregnancy was terminated in some other way). This will also, of course, be the date of birth of the baby.

4. LEGIT. OR ILLEGIT. If the baby is *legitimate* draw a line around LEGIT. If the baby is *illegitimate* draw a line around ILLEGIT.

5. COLOR. If the woman to whom the card applies is *white*, draw a line around W. If the woman is *colored*—negro, mulatto, etc.—draw a line around C.

6. RACE STOCK. The purpose of this item is to get some record of the racial origins of the persons included in the records. There follows a printed list of the official designations of racial stocks which may be found represented in the American population. Against each of these titles is a code number. These code numbers may be used instead of the titles in filling out this item on the cards.

RACIAL CODE

00 Scandinavian
01 Swede
02 Norwegian
03 Dane
04 Finnish

10 German
11 Dutch
12 Flemish

20 Russian
21 Slovak
22 Lithuanian and Ruthenian
23 Polish
24 Magyar
25 Croatian
26 Bohemian and Moravian
27 Bulgarian, Servian, Montenegrin
28 Roumanian
29 Dalmatian, Bosnian and Herzegovinian

30 Hebrew

40 English
41 Irish
42 Scotch
43 Welsh

50 Italian, South
51 Italian, North
52 French
53 Portuguese
54 Spanish
55 Greek

60 Syrian
61 Armenian
62 Turkish

70 Cuban
71 Mexican
72 West Indian (except Cuban)
73 Spanish-American

80 Japanese
81 Chinese
82 Korean
83 East Indian
84 Pacific Islander

90 Negro

98 North American (to be qualified in every case by indication of racial stock from which descended)

Thus, if the woman is native born of native parents, the appropriate designation is $98 \begin{matrix} 98 \\ 98 \end{matrix}$.

If it is known that the woman is native born of native parents, but the parents were of German descent, the appropriate designation is $98 \begin{matrix} 98\text{-}10 \\ 98\text{-}10 \end{matrix}$.

If the woman is native born but of German parents the appropriate designation is $98 \begin{matrix} 10 \\ 10 \end{matrix}$, but if her father was German and her mother English, the appropriate designation is $98 \begin{matrix} 10 \\ 40 \end{matrix}$.

If the woman is a Russian Jewess, the appropriate designation is 30—20.

It is hoped that the above examples will make clear the method of procedure under this item. But if there is doubt or difficulty either write to Doctor Pearl or consult the Supervising Field Worker upon her next visit to your hospital, for further explanations and instructions.

7. RELIGION. Write in the religious affiliation or preference of the patient, as, for example: Methodist, Catholic, Jewish, etc.

8. GYNECOLOGICAL DISEASE. If the patient has, or at any time in her life has had any gynecological disease, such as, for example, salpingitis, uterine myomata, etc., write down its name in this space. If she has ever been surgically treated for any gynecological disorder this fact should be specified, as, for example, "dilation and curettage following abortion," etc.

9. REPRODUCTIVE HISTORY. The purpose of the three columns under this head is to include a succinct but complete record of all the pregnancies which the woman who is the subject of the card has ever had. It is one of the most important records of the whole study. Therefore great pains and care should be taken in filling it out, to the end that the resulting record may be accurate and complete.

a. *Pregnancy.* The first column prints the ordinal number of the patient's successive pregnancies, whatever their outcome, beginning with the first and going to the 16th. In case that some particular woman is pregnant for the 16th (or some greater) time, the table should be extended as far as necessary by attaching to her card a sheet of paper setting forth the additional data for which there is no space on the card.

b. *Year.* In this column is to be recorded the *year* in which each successive pregnancy *terminated.* Thus, if the patient had her first baby born in 1917, you will write in the year column, in the row marked "1," the figures 1917, and correspondingly, ***mutatis mutandis,*** for all other pregnancies, ***including the present one.***

c. *Result.* Each of the patients' pregnancies must terminate, or have terminated, in one, and only one of the following ways: (1) By the birth of a live baby. If this is a fact draw a circle around the "L" in this column; (2) By the birth of a stillborn baby, in which event draw a line around the "S" in this column; (3) By a spontaneous miscarriage at any time in the course of the pregnancy, in which event draw a line around the letter "M" in this column; (4) By an abortion legitimately induced by a qualified medical man for therapeutic reasons (such as danger to the mother's life from some complicating disease) at any time during

pregnancy, in which event draw a line around the letter "T" in this column; (5) By an abortion induced for criminal or other non-therapeutic reasons, in which event draw a line around the letter "O" in this column.

In case a particular pregnancy results in *twins* the fact should be noted on the card, in connection with the year of that pregnancy. Further it should be noted for each of the pair of twins whether it was "L," "S," "M," "T," or "O," in the manner indicated above for single births.

HOSPITAL Sinai

OBST. NO. 12345

| COLOR | RACE STOCK |
|---|---|
| (W.) C. | 98 < 98 / 98 |

**REPRODUCTIVE HISTORY**
INCLUDING PRESENT ADMISSION

| PREGNANCY | YEAR | RESULT |
|---|---|---|
| 1 | 1916 | (L) S. M. T. O. |
| 2 | 1918 | (L) S. M. T. O. |
| 3 | 1919 | L. (S.) M. T. O. |
| 4 | 1921 | L. S. M. T. (O.) |
| 5 | 1921 | L. S. M. T. (O.) |
| Twins 6 | 1932 | L. S. (M.) T. O. |
| 7 | | L. S. M. T. O. |
| 8 | | L. S. M. T. O. |
| 9 | | L. S. M. T. O. |
| 10 | | L. S. M. T. O. |
| 11 | | L. S. M. T. O. |
| 12 | | L. S. M. T. O. |
| 13 | | L. S. M. T. O. |
| 14 | | L. S. M. T. O. |
| 15 | | L. S. M. T. O. |

L=LIVE BABY. S=STILL BORN.
M=SPONTANEOUS MISCARRIAGE
T=THERAPEUTIC ABORTION.
O=OTHER ABORTION

FIG. 3. SHOWING HOW THE HYPOTHETICAL REPRODUCTIVE HISTORY DESCRIBED IN THE TEXT WILL APPEAR WHEN RECORDED ON THE CARD

The method of filling out the records under this general head *Reproductive History* may be made clearer by describing a hypothetical case and illustrating the filled out card.

A woman had her first pregnancy and a live baby in the first year after her marriage in 1916. This was followed by a second pregnancy and live baby two years later. In the following year a pregnancy led to a stillborn child. In the second year following she became pregnant twice, and resorted to an abortionist both times. There followed a long rest till the present pregnancy which resulted in a spontaneous miscarriage of twins.

The record of this woman's reproductive history would appear on the card as shown in Figure 3.

10. FIRST CONTRACEPTIVE QUESTION. If the patient has ever used any method or methods for the prevention of conception, or any methods which she used in the belief that they would produce such effect, draw a line about the word YES in this space.

If she has never used any such methods of any sort whatever, draw a line around the word NO in this space.

In case the answer is "yes," fuller details will be recorded on the other side of the card.

11. DATES OF BIRTH AND MARRIAGE. These three dates of the (a) birth of patient, (b) birth of her husband, and (c) of their marriage, are most important for the purposes of this investigation. Therefore great pains should be taken to get them accurately. In each case the date should be written out in full (as April 10, 1931) and *not abbreviated.*

*In case the patient has been married more than once* the necessary dates for *each* marriage (i. e., date of birth of husband and date of marriage) should be given. Also there should be entered the date of, and reason for (death, divorce, etc.), the termination of each marriage that has terminated. In case the married couple has ceased living together (desertion, separation, etc.) at any time, the date of such interruption of the married relation should be recorded. Also if, under such circumstances, marital relations are again resumed, the date of such resumption should be recorded.

12. WARD OR PAY PATIENT. If the patient occupies a free ward in the hospital and pays nothing draw a line around the word WARD. If the patient occupies a private room or pays the regular charges for her hospitalization, draw a line around the word PAY. If the patient pays for only a part of the regular charges, in either ward or private room, draw a line around the words PART PAY.

13. OCCUPATION. In this space write briefly but clearly, the occupations which have been followed by the patient's husband, as "machinist," "insurance agent," "unskilled laborer," "barber," etc.

14. EDUCATION. If the patient cannot read or write draw a line around the word ILLITERATE. If the patient has attended primary, intermediate, or other elementary grade schools, but has *not* attended high school, draw a line around the words ELEMENTARY SCHOOL. If the patient has attended high school but

has *not* attended college or university draw a line around the words HIGH SCHOOL. If the patient has attended a college or university, draw a line around the word COLLEGE.

15. ECONOMIC POSITION. The purpose of this item is to provide a further approximation to the social and economic status of the patient. It is realized that this is a difficult and embarrassing matter to take up directly with the patient. On this account the classification is purposely made very broad, because it is expected that only the interne's judgment or estimate of the situation will be given. But in most cases the interne will in fact have a fairly accurate notion of the economic status of each patient.

The classification is intended to have the following meanings:

If the patient is very poor; her family on the border line of actual subsistence requirements; sometimes requiring charity aid; draw a line around the words VERY POOR.

If the patient and her family are above the last mentioned status; never requiring charity aid; but compelled to live in the most careful and modest way; the typical workingman's family (except for the upper grades of skilled labor) draw a line around the word POOR.

If the patient and her family have enough to live on comfortably; educate the children through high school, enjoy modest luxuries and amusements, live in comfortable, well-kept homes; as the upper levels of skilled workmen, artisans, small shop-keepers, etc.; in short like the *average* of the great mass of the American population, draw a line around the words MODERATE CIRCUMSTANCES.

If the patient and her family are well-to-do; able to live in part from invested funds; perhaps belong to the professional classes; or managerial classes in business; are able to have whatever they want within moderate limits; send the children to college and university; draw a line around the word WELL-TO-DO.

If the patient or her family are rich or very rich; beyond the necessity of having to give serious consideration to economic matters because they have an invested fortune; draw a line around the word RICH.

16. INDUCED ABORTION. The questions here are self-explanatory. To indicate the answers draw a line around either YES or NO.

In case the answer is "yes" the method used should be described briefly, but as clearly as possible.

17. NOTES. This space is left for the purpose of permitting and encouraging the interne filling out the card to write down *anything whatever* that seems *to him (or her)* of special interest about the particular case recorded on the card. Here is your opportunity. Please use it.

18. THIS CARD WAS FILLED OUT BY: In this space should appear the *name*—not merely the initials—of the person filling out the card. If requested, the Department of Biology will furnish gratis a rubber stamp for this purpose.

19. METHODS OF CONTRACEPTION USED. We come now to the reverse side of the card. The information called for here forms, in a way, the keynote of the investigation. To get this information from the patient requires tact on the part of the worker, and the establishment of relations of mutual con-

fidence with the patient. Long experience in similar investigations has demonstrated, however, that it is possible to get the desired information in an accurate and trustworthy form in at least 99 per cent of all cases, provided the worker approaches the matter intelligently, sympathetically, and persistently. The Supervising Field Worker will give you personal instructions and suggestions regarding methods of handling the patient relative to this matter which have proved useful in previous experience. Do not accept a statement from the patient to the effect that she has never used any contraceptive method until by further questioning and study of her reproductive history in its entirety you are satisfied that her statement represents the real facts.

In the first column are listed all the commonly practiced methods of contraception. The patient may have used one or more, or none of these methods, or various combinations of them.

In the second column put check marks against any methods used.

In the third column write, in the same line as the checked methods, a statement of the length of time this specified method was used, as accurately as possible.

In the fourth column write down the patient's own opinion about the specified method.

Figure 4 gives an example of a hypothetical case which will indicate the sort of record desired.

*The Handling of the Records.* When the record cards reach the laboratory they are first checked in, as to numbers and source of origin, for the purpose of (a) keeping track of payments due the workers for the cards and postage, and (b) knowing what to send back to the workers in the way of supplies (blank cards and envelopes) so that their stock on hand may not be unduly depleted.

Each card is then gone over carefully and critically in detail to be sure (a) that each item of information called for has been duly entered: (b) that there are no inconsistencies or ambiguities in the record as it reaches us. If the card satisfactorily passes this scrutiny it is stamped with a serial number in the upper right-hand corner, and filed. If the card does not pass the inspection, a duplicate copy of it, *verbatim et litteratim,* exactly as it reaches us, is made. On this copy are placed blue pencil marks indicating the missing or doubtful items, and this copy together with a letter, discussing the matter and making plain what further information is wanted, is promptly mailed to the worker who originally sent it in, with a request that it be put in order and sent back to us as soon as possible. In the meantime the original is held in the laboratory here, without any serial number, until the case is cleared up, or it is found impossible to get the desired information. Only when the case has been disposed of in one or the other of these ways is it given a serial number and filed.

**METHODS OF CONTRACEPTION USED**
(TO BE FILLED IN WITH AS MUCH DETAIL AS POSSIBLE)

| METHOD | CHECK USE | HOW LONG WAS EACH OF SPECIFIED METHODS PRACTISED? | WHAT IS PATIENT'S OPINION AS TO EFFECTIVENESS OF METHODS SHE HAS USED? |
|---|---|---|---|
| COITUS INTERRUPTUS (WITHDRAWAL) | ✓ | Quite 18 months, after marriage. | Fairly safe but not satisfying to either husband or wife. |
| CONDOM {RUBBER / SKIN} | ✓ | Occasionally throughout methods, especially when travelling. | Unsatisfactory. Accidents liable with resulting pregnancy |
| PESSARY ALONE | | | |
| PESSARY WITH MEDICATED JELLY | | | |
| PESSARY WITH DOUCHE | ✓ | Regularly since abandonment of coitus interruptus until Jan. 1929. | Safe, but too much trouble. |
| MEDICATED VAGINAL SUPPOSITORIES OR JELLIES* | | | |
| DOUCHE ALONE—WATER | | | |
| DOUCHE ALONE—MEDICATED* | | | |
| INTRA-UTERINE MECHANICAL DEVICE* | ✓ | From Jan. 1929 to June, 1931, when all contraceptive use stopped to produce wanted baby. | Perfectly satisfactory. |
| "SAFE PERIOD" (ABSTINENCE DURING PART OF MONTH) | | | |
| ANY OTHER METHOD* | | | |

*SPECIFY KIND HERE: Gold "Ring" inserted in uterus by physician. Monthly inspection, removal, and cleaning by physician.

DO NOT WRITE IN THIS SPACE

OVER

FIG. 4. REVERSE SIDE OF RECORD CARD FILLED IN FOR A HYPOTHETICAL CASE

As the clerical staff in the office finds time they compute and enter on the finished cards certain data regarding elapsed times [33] (ages of husband and wife, duration of marriage, exposure to risk of pregnancy, etc.), make current tabulations of a few of the more important items of immediate interest, etc.

Eventually the records will be transferred to Hollerith punch cards for mechanical tabulation.

*Coöperating Hospitals.* The present paper deals with the first 2,000 completed cases only, and with but a very small fraction of the different sorts of tabulations and analyses which will eventually be made. As this paper goes to press the total number of hospitals coöperating in the work, either during some limited period in the past or regularly, is 131, and the total number of finished cards in the file is 13,008. It is expected that the collection of data will be continued until December 31, 1932. On that date the record taking will be stopped, and the complete analysis of the data pushed forward as rapidly as possible.

Table 1 shows the cities, hospitals, and persons filling out the cards, included in the first 2,000 cases.

TABLE 1

*List of Hospitals Coöperating in the First Two Thousand Cases*

| *Hospital* | *Persons making the records* |
|---|---|
| BALTIMORE | |
| The Johns Hopkins Hospital | Dr. E. P. Harrison<br>Dr. Katherine Kuder |
| University of Maryland Hospital | Dr. W. P. Dailey<br>Dr. W. A. Hart |
| Sinai Hospital | Dr. Sarah Roskis<br>Dr. Cohen |
| Union Memorial Hospital | Dr. J. M. Haws |
| Franklin Square Hospital | Dr. M. S. Schreiber |
| The Church Home and Infirmary | Dr. William L. Millea<br>Dr. Hedges |
| Provident (Colored) Hospital | Dr. Berkeley Butler |
| South Baltimore General Hospital | Dr. J. G. Feeman |
| West Baltimore General Hospital | Dr. Arthur C. Tiemeyer<br>Dr. John Rozum<br>Dr. Philip L. Lerner |

[33] *Cf.* Pearl, R., and J. R. Miner. A table for ascertaining elapsed time in years and decimals of a year between any two dates. *Quart. Bull. Milbank Mem. Fund,* Vol. 10, pp. 151-153, 1932.

TABLE 1—*Continued*

| *Hospital* | *Persons making the records* |
|---|---|
| **PHILADELPHIA** | |
| Abington Memorial Hospital | Dr. E. G. McDaniel, Jr. |
| University of Pennsylvania Hospital | Dr. R. B. Schutz |
| Woman's Hospital | Dr. Maytum<br>Dr. Carrie Hearn |
| Philadelphia Lying-In Hospital (Red Service) | Dr. Wyatt C. Simpson |
| Philadelphia Lying-In Hospital (Blue Service) | Dr. A. B. Peacock |
| Jefferson Medical College Hospital | Dr. C. E. Wolfrom |
| Kensington Hospital | Dr. J. M. Lemmon |
| Chestnut Hill Hospital | Dr. W. R. Thompson |
| Lankenau Maternity Hospital | Dr. Clark Brown<br>Dr. Bradford Green |
| Delaware County Hospital | Dr. Joseph Argoff |
| **WASHINGTON, D. C.** | |
| Washington Sanitarium | Dr. Edna Patterson<br>Dr. L. E. Kress |
| **CHICAGO** | |
| Presbyterian Hospital | Dr. Harry Boysen |
| Women's and Children's Hospital | Dr. Emily A. Svoboda |
| Chicago Lying-In Hospital and Dispensary | Dr. Beatrice Tucker |
| Lutheran Memorial Hospital | Dr. Helen L. Button |
| Research and Educational Hospital | Dr. Florence Hark |
| Augustana Hospital | Dr. John A. Booker |
| Chicago Memorial Hospital | Dr. Nathan Krupkin |
| Evangelical Deaconess Hospital | Miss Emma M. Schaab, R. N. |
| Mt. Sinai Hospital | Dr. Milton Steinberg |
| Wesley Memorial Hospital | Miss Bess Cooley |
| Frances E. Willard Hospital | Dr. Irene Sherman |
| Bethany Sanitarium | Miss Lela Moyer |
| Swedish Covenant Hospital | Dr. M. Elizabeth Downing |
| Michael Reese Hospital | Dr. Gemma Lichtenstein |
| St. Luke's Hospital | Dr. D. J. Ladd |
| **NEW YORK CITY** | |
| Harlem (Municipal) Hospital | Dr. Hyman Lieber |
| Lutheran Hospital of Manhattan | Dr. Helen Harmand |
| Booth Memorial Hospital | Dr. Frances E. Shields |
| Fifth Avenue Hospital | Dr. Frances E. Shields |

It will be seen from Table 1 that the first 2,000 cases came from the clientele of 39 hospitals located in five large cities. The total population of these five cities in 1930 was 13,549,588.[34]

*Acknowledgments.* I wish to take this opportunity of expressing my deep gratitude to the workers listed above for the painstaking care with which they have filled out the records, and their interest and enthusiasm in a laborious task undertaken in the face of other pressing duties and obligations. The mere pittance of 5 cents per card which we are able to pay is a grotesquely inadequate compensation for the time and trouble required. Without the fine spirit of unselfish altruism towards a scientific project on the part of these busy hospital workers the investigation would have been impossible. Also I wish to record my appreciation of the coöperative spirit and breadth of vision on the part of the chiefs of the obstetric services in permitting this work to be done in their hospitals.

Three Supervising Field Workers have been connected with the work to date. They are Iva M. Miller, M. D., C. P. H., (to the end of February, 1932), Gertrude Sturges, M. D. and Dorothy Cobb Adams, M. D. (from February, 1932, on). Theirs has been the often difficult and sometimes trying task of securing the coöperation of the hospital staffs in the first instance; then instructing the hospital workers in filling out the cards; and finally checking and rechecking their early reports. No praise is too high for the work they have done. During the period covered by the first 2,000 cases the office work in the laboratory connected with the project was most efficiently and intelligently performed by Helen Trybulowski (Mrs. Eric N.) Gillis.

Finally our warmest thanks are extended to Dr. George W. Kosmak, for his interest in the project and invaluable help in enlisting the cooperation of obstetricians in all parts of the country; and to Dr. Linsly R. Williams, for his help in organizing the work in New York City.

## SOME CHARACTERISTICS OF THE DATA

In any statistical study it is of the highest methodological importance to examine critically and formulate clearly the characteristics of the sample of the population forming its basis. The extent or degree to which the sample is differentiated (selected) from the population in

[34] Fifteenth Census of the United States: 1930. Population, Vol. I. Number and Distribution of Inhabitants. *Washington, D. C.* (Gov't. Printing Office) 1931. Pp. iv + 1268.

general should be as clearly apprehended and defined as possible. Such differentiation or selection definitely limits the breadth of possible generalization from the results.

From a statistical standpoint at least, the following general statements may at once be made about the material which has been, and will be, collected in this investigation.

The present data come from a portion of the general population of women living in the United States, and represent a *selected* group in respect of the following items, at least:

1. All the women are urban dwellers, in large cities.

The desirability of the study of these problems in rural populations is fully recognized. But we have not yet been able to devise any practical method of getting the data for such populations.

2. All the women have been delivered of a baby in a hospital at some date since July 1, 1931.

At least two sorts of selections are implied in this fact. The first is that which is implied in the fact that not all women have their babies in hospitals. Whether those who do are differentiated in any important biological characteristics from those who do not is unknown, but also improbable. It is of interest to note that the number of urban women who regularly resort to hospitals to have their babies is larger than might perhaps be supposed. The most recent data [25] available (June 11, 1932) give 708,889 births occurring in 1930 in all hospitals in the United States registered with the American Medical Association. In 1928 (the latest figures available) the total number of births in the U. S. Birth Registration Area (which was officially estimated at that time to include 94.4 per cent of the population) was 2,233,149. It thus appears that something of the order roughly of a third of all deliveries at the present time are taking place in hospitals. In large cities the proportion is probably still higher.

The second implied sort of selection is more important. Our sample includes only women who were overtly fertile during the period of the study. No women permanently sterile for physiological or pathological reasons pertaining to themselves or their consorts can possibly be included in the records. No women temporarily sterile during the period of the investigation (July 1, 1931 to December 31, 1932) or during a prior period of nine months before the first date—for any reason whatsoever—can possibly appear in the data.

[25] "Hospital Number" of the *Jour. Amer. Med. Assoc.*, Vol. 98, p. 2067, 1932.

The first of these limitations has no further bearing upon this investigation than that implicit in the fact itself. That is to say, we have deliberately chosen for this investigation a methodology which confines its universe of discourse to fertile matings, and conversely excludes childless matings (both those physiologically sterile—that is matings in which pregnancy never occurs—and those, if any, in which pregnancies have always terminated in unrecorded abortions). There is nothing in this procedure that can be justly criticised. Any investigator has the privilege to adjust his *Fragestellung* so as to limit his universe of discourse within defined bounds. Since this point will not be discussed again in this paper it may be of interest to see about what percentage of matings is excluded by restricting the data to those that are fertile. Writing in 1866 Matthews Duncan [36] (p. 186) reached the conclusion, from a process of statistical reasoning perhaps somewhat less than perfect, that "15 per cent of all the marriages between fifteen and forty-five years of age, as they occur in our population, are sterile." By "our population" here is meant Edinburgh and Glasgow. Lotka [37] concludes his careful and thorough study of the matter with the following words:

"The *effective* or *gross* sterility of marriages of American (white) wives has been computed as 17.1 per cent. Of this about 1.2 per cent is due to the premature death of wives who otherwise would eventually have had a child; 2.0 per cent further is due to premature deaths of husbands whose wives would otherwise eventually have had a child. A further 0.8 per cent is due to childlessness resulting from divorces in couples that would eventually have had a child.

"The *net* sterility of marriages of American (white) wives is accordingly 17.1 — 1.2 — 2.0 — 0.8 = 13.1 per cent."

Notestein [38] shows in his Table 2 (p. 184) that the percentage in a sample of native white married women, once married, and living north of the Mason and Dixon Line, aged 40-44 at the 1910 census, who had borne no children ranged from 10.6 per cent in the "Farm Owners" class to 19.8 per cent in the "Professional" class. Corresponding figures for women 60-64 years of age at the same time range from 4.4 per cent in the "Unskilled Laborer" class to 14.7 per cent in the "Professional"

[36] Duncan, J. M. Fecundity, Fertility, Sterility and Allied Topics. *Edinburgh* (A. and C. Black) 1866. Pp. xvi + 378.

[37] Lotka, A. J. Sterility in American marriages. *Proc. Nat. Acad. Sci.*, Vol. 14, pp. 99-109, 1928.

[38] Notestein, F. W. *Loc. cit.*, footnote 21.

class. Sanders [39] finds, for completed families (taken as marriages lasting 15 or more years) the percentage with no children to run from 6.2 per cent (marriages contracted 1879-1893) through 7.1 (1893-1903) to 10.0 (1904-1913).

The second limitation to the generality of the present data consequent upon its restriction to women delivered in a hospital is more important. It is obvious that one reason why a woman, who would otherwise fall within our collecting net, had no baby during the period covered may have been that she was practising contraception with 100 per cent effectiveness during that time. To the extent that such women (otherwise eligible) existed they are automatically excluded from the present data. This means that the present data will insofar underestimate the proportion of women practising contraception in the defined sample. But from this fact the false inference should not be drawn that *all* the women, who would have been delivered in hospital during the period of this study if they had had a baby, did not have a baby because they practised contraception with perfect efficiency. All women who do not practise contraception are not always pregnant. In the present case all that is really known is that otherwise eligible women who did not become pregnant during the period defined above are automatically excluded from the data. There is no logical warrant from this fact alone—and it is again emphasized that this fact is all we know in the premises—to draw inferences as to *why* such women did not become pregnant. To find out these reasons demands a special *ad hoc* investigation, which forms no part of the present purpose of this preliminary paper.

3. There are definite geographical limitations to the data discussed in this paper. These are defined in Table 1 *supra*.

4. No data were collected from hospitals controlled by the Roman Catholic Church.

The reason for this voluntary limitation on the collecting of material is a simple one. The Catholic Church is officially opposed to the practice of contraception. Even if Catholic hospitals were willing to coöperate in such an investigation as this, it is improbable that a patient of that faith who had in fact practised contraception would be willing to admit it to a Catholic physician in a Catholic hospital. Catholic women are included in the data. But they attended non-Catholic hospitals for their deliveries.

[39] Sanders, J. *Loc. cit.*, footnote 11.

In addition to the above differentiations of the present sample from the general population of women there are some others of a social or economic character which will now be dealt with in separate sections.

*Race.* In the first 2,000 cases here discussed 1,390, or 69.5 per cent, were white women; and 610, or 30.5 per cent, were colored (negro). These proportions have no particular demographic significance. The negro population of the five cities contributing to the present sample forms a much smaller fraction of the total population than 30 per cent. But some purely negro hospitals (as the Provident in Baltimore) are included in the records, and others (as Harlem in New York) have a high proportion of negroes in their clientele. Furthermore it appears to be the fact that in many large cities the negroes have become, as a group, well aware of the superior medical service in the large hospitals that is either theirs for the asking, or in the worst case by the payment of small fees. Many a Baltimore cook is proud of the fact that every one of her six, eight, or ten children, as the case may be, has been born in the Johns Hopkins Hospital. It is, however, probable that as larger numbers of the records are tabulated the percentage of negroes in the totals will be smaller than in the first 2,000, where the Baltimore and Philadelphia hospitals are rather heavily weighted.

*Economic Status.* As stated above, the plan of the study was to have *every* woman delivered of a baby in any of the coöperating hospitals included in the records. Early in the work, however, it was made apparent that this was an unattainable ideal. Many obstetricians refused to permit the collection of the information from their private cases, although perfectly willing to coöperate in the completest way so far as concerned ward cases and pay patients not the private cases of any particular physician. This position automatically and almost completely cuts out of the records women in the higher economic and social brackets. It was possible, however, to bear this limitation of the data with some equanimity, because of two considerations. The first is that it seems reasonably certain, on the basis of common knowledge, that there are but relatively few women in the highest economic and social brackets in the populations of large cities who do not practise some form of what they at least believe to be contraception. In the second place where information is most needed regarding the problems of this study is in respect of the masses—the less fortunate economically. It is just here that the present material furnishes information.

Table 2 shows the distribution of the 2,000 cases into the five broad economic classes defined in an earlier section of this paper.

TABLE 2

*Economic Status of the 2,000 Cases Here Discussed*

| CLASS | WHITE | | NEGRO | | TOTAL | |
|---|---|---|---|---|---|---|
| | Number | Per cent | Number | Per cent | Number | Per cent |
| Very poor | 174 | 12.5 | 252 | 41.3 | 426 | 21.30 |
| Poor | 704 | 50.6 | 338 | 55.4 | 1,042 | 52.10 |
| Moderate Circumstances. | 476 | 34.2 | 20 | 3.3 | 496 | 24.80 |
| Well-to-do | 35 | 2.5 | ... | ... | 35 | 1.75 |
| Rich | 1 | .1 | ... | ... | 1 | .05 |
| Totals | 1,390 | 99.9 | 610 | 100.0 | 2,000 | 100.00 |

From Table 2 it appears that, in this sample of 2,000, over 63 per cent of the white group and over 96 per cent of the negro group fell below the "Moderate Circumstances" grade as defined earlier.

A cursory examination of the records of the occupations of the husbands in this series of cases leads one to the tentative view that the whole distribution as shown in Table 2 is definitely pushed down towards the lower end of the scale as a result of the general economic and industrial depression prevailing during the period covered by the investigation. In many cases in the records skilled artisans, for example, who in good times would fall into the "Moderate Circumstances" group, had been long unemployed and were in actual fact "poor," and in some cases "very poor" at the time the records were made.

*Education.* Table 3 gives the distributions relative to the extent of the formal education of these 2,000 women. The significance of the classes has been explained in an earlier section.

TABLE 3

*Education of the 2,000 Women Studied*

| HIGHEST STAGE OF FORMAL EDUCATION RECEIVED | WHITE | | NEGRO | | TOTAL | |
|---|---|---|---|---|---|---|
| | Number | Per cent | Number | Per cent | Number | Per cent |
| Illiterate | 36 | 2.6 | 29 | 4.7 | 65 | 3.25 |
| Elementary | 903 | 65.0 | 417 | 68.4 | 1,320 | 66.00 |
| High School | 394 | 28.3 | 148 | 24.3 | 542 | 27.10 |
| College or University | 57 | 4.1 | 16 | 2.6 | 73 | 3.65 |
| Totals | 1,390 | 100.0 | 610 | 100.0 | 2,000 | 100.00 |

Two points brought out by Table 3 seem noteworthy. The first is that the proportion of women in this sample with the record of attendance at a high school (including those attending college or university, because presumably all of the latter had first gone through high school) is fairly high and perhaps not very far below the corresponding proportion in the general urban population.[40] The second is that the proportionate figures are so nearly the same for the colored and white groups.

*Marital Status.* Out of the 2,000 women included in this paper 1,824, or 91.2 per cent, were living in wedlock at the time of the making of the record, and 176, or 8.8 per cent, were not. Nearly all of the latter were young unmarried girls having their first illegitimate child. In the white group 1,348, or 97 per cent, of the mothers were married, and 42, or 3 per cent, were unmarried. In the negro group 476, or 78.1 per cent, were married, and 134, or 21.9 per cent, were unmarried. This difference between the two racial groups is in accord with normal expectation in its sense.

*Reliability.* There is no particular *a priori* reason to doubt the reliability of the information recorded on the cards save in one respect to be presently discussed. Experience has shown that all family records are subject to natural errors arising from forgetfulness and carelessness. Some mothers do become vague about how many children they have had, and may forget the particular years in which they were pregnant. But in such respects the figures here dealt with are on no worse footing than are the official returns of the Census Bureau. As a matter of fact the present data are presumably on a higher plane of accuracy, in general, than any census data, because they are collected by trained medical men and women, and in the atmosphere of medical institutions (hos-

[40] I have not been able to locate any definitive figure for any general population on this point. But from casual remarks of well-informed educators which I have come upon in cursory reading I infer that roughly something of the order of 50 per cent of the total population of girls within high school age limits attend high school for some period of time. A press release of the Department of the Interior, as of June 30, 1932, states that "Enrollment . . . . of high school age boys and girls" is "approximately 50 per cent today." This is based upon the findings of the National Survey of Secondary Education provided for by Congress and lasting three years, which was directed by Dr. Leonard V. Koos of the University of Chicago. Until the complete report has been published and studied it is impossible to form any judgment as to the statistical reliability and significance of this figure of 50 per cent. Mr. H. E. Buchholz, the well known authority on educational matters, to whom I am indebted for bringing this news release to my attention, tells me that in his opinion 45 per cent would probably be nearer the truth.

pitals) with high standards of scientific accuracy in the making of records. The recorder has the individual under observation usually from ten days to two weeks before making the record.

But in one important respect the present records are more intimately personal than official vital statistics; though not more so, be it noted, than obstetric and gynecological histories taken regularly and generally from patients in those departments of a modern, teaching hospital. We ask the patient whether she has used any method to avoid becoming pregnant. Her response may take one or the other of three forms. She may say yes, or no, or refuse to answer. If the answer is yes, there would seem to be no reason to doubt that she is telling the truth. There would be no motive to allege that she had practised contraception when she had not. Furthermore if she answers "yes" to the first question she must then describe in detail the methods used. It would be idle to allege that a trained medical worker, accustomed to taking case histories from patients, would not know if the woman were lying in this direction.

In the case of the third alternative (refusal by the patient to answer) the case would not appear in the records at all. Experience in this investigation, and in earlier unpublished studies of a similar character to the present one, has demonstrated that the number of women who flatly refuse to discuss this matter with their hospital physician, is extremely small—so small as not to affect the adequacy of the sampling in an appreciable degree.

This leaves for discussion only the second alternative. There may be a motive for a patient to say that she has not practised contraception when she has. This motive may be either personal, or religious, or social, or some sort of vague fear of consequences. Thus a Catholic patient in a Catholic hospital with a priest beside her bed would presumably be disinclined to say that she had practised contraception. But, as already stated, we have not included Catholic hospitals in our study, and for just this reason. Furthermore it needs to be considered that, again, a medical man or women trained in history taking, becomes adept in detecting falsehoods in the patient's statements. Notations on the cards indeed occasionally tell of the breaking down of an original "no" to the contraception question, and the eliciting of a final affirmative answer and the whole detailed story. The whole relationship between patients and their physicians works greatly in favor of the getting of accurate and reliable answers. Normal women trust their physicians. After a

delivery they are grateful for the care and attention they have had. They have no fear of the violation of their confidences. Another point is that the reproductive record itself often gives the recording physician a clue to further questioning if a women at first says she has not practised contraception but actually has.

The methodology of the scientific study of human behavior in sexual matters has lately been discussed with critical acumen by Harvey.[41] His final conclusion is (p. 185) that: "Combining the questionnaire with the case study, as complementary functions of the same method, should yield the most productive as well as the most reliable results in the study of human sexual behavior." It will be plain from what has preceded that a combination of the case and questionnaire techniques is precisely the methodology of this present investigation. As in the case method a technically trained person gets the data from the individual; the information is kept within a prescribed pattern as in the questionnaire; the multiplication of cases is achieved by the employment of many trained observers. The inevitable small loss in uniformity of viewpoint which this latter point entails will, to a considerable extent, be compensated for in the end result by the large amount of material which will be obtained—so large as to be statistically respectable.

Altogether, after careful study of these records, and many years experience in collecting data regarding sexual matters, I have a considerable degree of confidence in the general accuracy of these records. I am sure they are not 100 per cent accurate, in the sense of the physical sciences. No records in human biology, "official" or otherwise, ever are, and are not likely to be. But I am equally confident that these records as to contraception are of the same general order of individual reliability as age records in a census report, and more reliable than records of cause of death in mortality statistics. In the present case, just as in demographic statistics generally, the data may be regarded as sufficiently accurate individually to warrant careful analysis, and at the same time containing enough errors to compel caution in drawing conclusions.

## RESULTS

### A. *Fertility*

As a first step in the examination of the records it will be useful to examine the frequency distributions of the 2,000 women by number of

[41] Harvey, O. L. The scientific study of human sexual behavior. *Jour. Soc. Psychol.*, Vol. 3, pp. 161-188, 1932.

pregnancies which they have experienced. The data are presented in Table 4. In this table the first column gives the total number of *pregnancies* (*not* births) *ever* experienced. The following columns headed respectively "Number" and "Per cent" give the absolute and relative frequencies of the women who have experienced each of the designated numbers of pregnancies. The columns headed "Per cent children ever born, 1927" give the percentage of frequencies of mothers in the U. S. Birth Registration Area who in 1927 bore a child and had in total, including that child, borne the number of children designated [42]

TABLE 4

*Frequency Distributions of 2,000 Women by Number of Pregnancies Ever Experienced, Together with Distributions of Mothers of the Year 1927, in the U. S. Birth Registration Area, by Number of Children Ever Born*

| NUMBER OF PREGNANCIES | WHITE | | | NEGRO | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Per cent | Per cent children ever born 1927 | No. | Per cent | Per cent children ever born 1927 | No. | Per cent | Per cent children ever born 1927 |
| 1 ..... | 593 | 42.7 | 30.21 | 236 | 38.7 | 29.15 | 829 | 41.45 | 30.04 |
| 2 ..... | 285 | 20.5 | 22.20 | 129 | 21.1 | 17.94 | 414 | 20.70 | 21.76 |
| 3 ..... | 169 | 12.2 | 14.79 | 76 | 12.5 | 12.94 | 245 | 12.25 | 14.62 |
| 4 ..... | 116 | 8.3 | 10.11 | 54 | 8.9 | 10.06 | 170 | 8.50 | 10.13 |
| 5 ..... | 78 | 5.6 | 6.85 | 35 | 5.7 | 7.75 | 113 | 5.65 | 6.96 |
| 6 ..... | 41 | 2.9 | 4.96 | 28 | 4.6 | 5.97 | 69 | 3.45 | 5.07 |
| 7 ..... | 36 | 2.6 | 3.57 | 9 | 1.5 | 4.64 | 45 | 2.25 | 3.68 |
| 8 ..... | 21 | 1.5 | 2.59 | 13 | 2.1 | 3.49 | 34 | 1.70 | 2.68 |
| 9 ..... | 9 | .6 | 1.77 | 7 | 1.1 | 2.52 | 16 | .80 | 1.84 |
| 10 ..... | 25 | 1.8 | 1.24 | 12 | 2.0 | 1.99 | 37 | 1.85 | 1.31 |
| 11 ..... | 9 | .6 | .75 | 3 | .5 | 1.29 | 12 | .60 | .81 |
| 12 ..... | 2 | .14 | .47 | 5 | .8 | .92 | 7 | .35 | .51 |
| 13 ..... | 2 | .14 | .24 | 1 | .2 | .58 | 3 | .15 | .28 |
| 14 ..... | 1 | .07 | .13 | 2 | .3 | .33 | 3 | .15 | .15 |
| 15 ..... | 2 | .14 | .06 | .. | .. | .20 | 2 | .10 | .07 |
| 16 ..... | .. | .. | .03 | .. | .. | .10 | .. | .. | .04 |
| 17 ..... | 1 | .07 | .02 | .. | .. | .05 | 1 | .05 | .02 |
| 18 and over... | .. | .. | .02 | .. | .. | .06 | .. | .. | .02 |
| Totals ..... | 1,390 | 99.86 | 100.01 | 610 | 100.00 | 99.98 | 2,000 | 100.00 | 99.99 |

[42] These Birth Registration Area figures are computed from data given in Table II, pp. 43-47, of Birth, Stillbirth, and Infant Mortality Statistics . . . . 1927. Part I. *Washington* (Bureau of the Census). 1930.

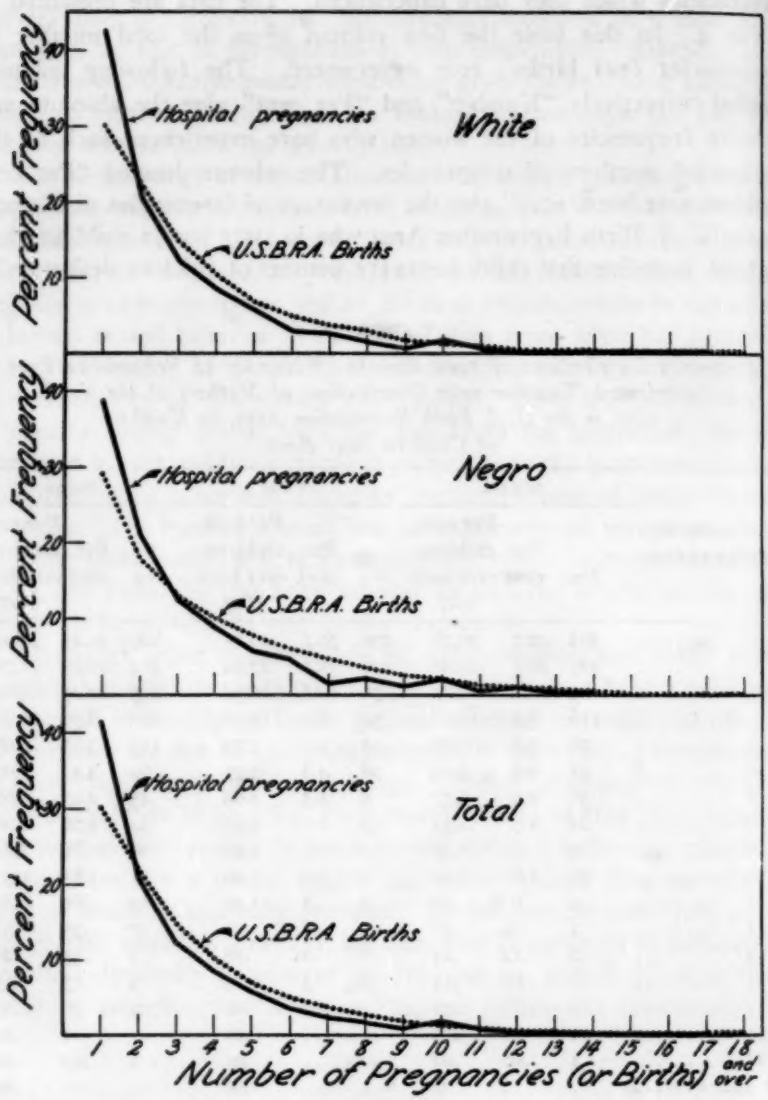


FIG. 5. NUMBER OF PREGNANCIES EVER EXPERIENCED BY WOMEN OF PRESENT SAMPLE (SOLID LINES) AND NUMBER OF CHILDREN EVER BORN (U. S. B. R. A., 1927) (DOTTED LINES)

in the first column of Table 4. These figures are not, of course, strictly comparable with the pregnancy figures of the present data. But they are the nearest comparable of anything available in official statistical reports for the general population. Furthermore, total pregnancies and total children born, are highly correlated variables. The essential data of Table 4 are shown graphically in Fig. 5.

The following points are to be noted from Table 4 and Fig. 5:

1. In the present sample of material there is a remarkably close agreement between the white and negro groups in respect of the relative (percentage) frequency of women who have experienced the various numbers of pregnancies. While there is a systematic difference between the two curves in the direction of higher fertility in the negroes, the difference is not as great as perhaps might have been expected. The white group shows a considerably higher percentage of single (first) pregnancies than the negro group. An increasing proportion of first pregnancies among white women in this country, accompanying the declining birth rate, has been noted by various observers.

2. The proportion of single (first) pregnancies is much higher, in both the white and negro groups, than the corresponding proportion of first (only) births among women in the Birth Registration Area bearing children in 1927. On the other hand the percentages of women (B. R. A. 1927) who have borne 3 or more children are practically uniformly higher than the corresponding percentages for the pregnancies among the women of the present sample. Taken at face value this indicates that this group of 2,000 women delivered of babies in hospitals between July 1931 and March 1932, had, during their lives, exhibited a distinctly lower fertility rate than had the women in the B. R. A., who had a baby in 1927. This is so for both the white and the negro groups separately, and consequently necessarily so for the total.

3. The point just discussed may be shown in another way. 1,978,345 women who produced babies in the B. R. A. in 1927 had, in their whole lives up to that time, borne a total of 6,395,858 children. This gives an average of 3.23 children ever born, per mother. In contrast to this the 2,000 women of the present sample had experienced, in total, 5,496 pregnancies during their lives up to the time of record, giving an average of 2.75 pregnancies per woman. For white women only (respectively 1,775,313 and 1,390) the numbers of children ever born and pregnancies ever experienced are respectively 5,651,007 and 3,731, leading to averages of 3.18 children per mother and 2.68 pregnancies per woman. The

apparent difference in fertility between the two samples is still more marked in the negroes. 193,689 B. R. A. mothers of 1927 had produced, up to that time, a total of 708,524 children, an average of 3.66 children per mother. The 610 negro women in the present sample had experienced in total, up to the time of record, 1,765 pregnancies, or an average of 2.89 pregnancies per woman.

4. It cannot, however, be assumed on the basis of the preceding evidence alone that the differences between our sample and the B. R. A. mothers of 1927 discussed in the two preceding paragraphs are representative of real differences in fertility. A part of the apparent differences may possibly be due to significantly different age distributions of the mothers in the B. R. A. and the present sample. This point will be discussed in detail later, when the complete material is available.

In section C below the question of fertility will be further considered, and in a more precise way.

## B. *Contraception*

*Frequency.* Table 5 gives the data regarding the proportion of these 2,000 women who have at some time, or regularly, practised contraception, or at least what they supposed to be contraception.

TABLE 5

*Showing the Absolute and Relative Numbers, Among 2,000 Women of (a) Those Who Have Used Some Method or Methods for Preventing Conception, and (b) Those Who Deny Any Use of Such Methods*

| | WHITE | | NEGRO | | TOTAL | |
|---|---|---|---|---|---|---|
| | Number | Per cent | Number | Per cent | Number | Per cent |
| a. Those who have used some method, or methods, regularly or intermittently, for preventing conception ..... | 497 | 35.8 | 94 | 15.4 | 591 | 29.55 |
| b. Those who deny the use of any method for preventing conception. | 893 | 64.2 | 516 | 84.6 | 1,409 | 70.45 |
| Totals ..... | 1,390 | 100.0 | 610 | 100.0 | 2,000 | 100.00 |

The following comments may be made upon Table 5:

1. In this group of 2,000 women taken as a whole the practice of some form of contraception was rather more than twice as prevalent relatively among the white women than it was among the negro women. This result accords with what would be expected *a priori*. The American negro, probably generally and certainly under urban conditions, exercises less prudence and foresight than white people do in all sexual matters. Another way in which this is shown is in the relative prevalence of venereal diseases, which are generally much more common among the negroes than among the whites. The use of contraceptive methods demands some degree of intelligent foresight. This is an attribute, or a combination of attributes, more prevalent among whites than among negroes. The experience of contraceptive clinics in cities has shown that any method of contraception known at present is not particularly effective with the general population of negroes. They need something which is more automatic and requires less intelligent co-operation and foresight on the part of the individual.

2. Just under 36 per cent of the 1,390 white women had ever used any means to prevent conception. For the 1,348 married white women living in wedlock the percentage practising contraception rises insignificantly to 36.6 per cent. There appear to be no precisely comparable data from other sources. In Davis's [43] group of 1,000 married women 692 were college or university graduates, and only 62 had less than a high school education. The group belonged to a much higher average social level than the women furnishing the present data. In the Davis group the percentage reporting the use of contraceptive methods was 74.11 per cent (Table 1, p. 14) as against the 36.6 per cent for white married women in the present material. The 62 with "less than high school" education (of whom, however, 39 had attended "one to three years in high school") gave 64.51 per cent affirmative answers as to the use of contraceptive methods. The schedules for the collection of the data used by Brown, Greenwood, and Wood [44] were not drawn in such a way as to lead to great precision in the returns on the question of practice of contraception. The statement made by these authors is (p. 199): "Among collegians a minimum of 47.4% [of families] and

[43] Davis, Katherine B. *Loc. cit.*, footnote 20.
[44] Brown, Greenwood and Wood. *Loc. cit.*, footnote 15.

perhaps as many as 62.13% are ostensibly of limited fertility;[45] the corresponding figures for non-collegians are 39.87% and 54.95%." Their Table XLV (p. 200) indicates that the lower percentages quoted are the ones which should presumably be compared with the present data, if any comparison at all is to be made. They are the percentages of those definitely replying "yes" to the question "was family intentionally limited?" The figure of 39.87 per cent for the non-collegiate group is not far from the 36.6 per cent shown by the married white women in the present sample. But again it must be emphasized that the social, economic and educational level of the Brown, Greenwood, Wood non-collegiate group was much higher than that of the present sample. Their non-collegiate group consisted of sisters (or cousins) of those in the collegiate group. The material of Dickinson and Beam[46] furnishes little that is pertinent to the present point under discussion. These authors apparently assumed *a priori* that, amongst their group of private patients consulting a gynecologist, virtually 100 per cent practised contraception. They say (p. 248):

> The hypothesis is that in this series birth is usually controlled. This is safe to assume because it was true in the great majority of cases where the question was raised. There was no need to ask every patient about this: only those with serious conditions contra-indicating pregnancy; those seen after childbirth; or for problems of sexual or reproductive life. Such cases afford 532 instances of information as to how fertility was or was not controlled. Only twenty-five, or fewer than one in twenty, had never used any form of control. In 507 cases some form was used, or was unnecessary because of sterility or sterilization.

3. As has already been pointed out in an earlier section of this paper, the percentages in Table 5 of those practicing contraception are to be regarded as minimum figures. We are justified in saying that in this sample of material *at least* 35.8 per cent of the white women, and 15.4 per cent of the negro women had practised some form of interference with conception. It will doubtless be alleged that some of the women recorded as not having practised contraception gave false information on the point, and should really be included with the positive group. I have given reasons earlier in this paper for the belief that the number of such women, if any, is probably very small. But let us make the assumption that 20 per cent of the white women who said that they had never practised contraception lied when they said so. Transferring

[45] What the authors mean by "ostensibly of limited fertility" is, I think, that the schedules taken at their face value indicate that in the stated percentages of mated pairs some sort of conscious effort was made to reduce the fertility of the mating.

[46] Dickinson and Beam. *Loc. cit.*, footnote 27.

them to the other group would give a hypothetical total of 675.6 women admitting the practice of contraception. But this is still only 48.7 per cent, or less than half, of the total white women (1,390) in the sample. This is, however, an extreme assumption of unreliability in the data. No one connected in any way with the work, or having direct contact with the patients, would entertain it for a moment. It represents probably at least ten times any actual falsification that may possibly be present in the data on the point.

4. In sum, it appears that among the 2,000 women in this sample, coming preponderantly from the lower social and economic classes in large urban centers, the practice of contraception is far less prevalent than it has been assumed to be by some of those who have discussed the problem of declining birth rates, and is much less frequent than in the classes on higher social and economic levels.

*Methods of Contraception Used.* The data regarding the methods of contraception used by the 591 women in the sample of 2,000 who used such methods at all, are given in Table 6. It should be noted that in many cases a woman tried different techniques at different times. This explains why the totals in the table are greater than the numbers of women practising contraception. If a particular mated pair tried first coitus interruptus, and then later adopted the use of a pessary as a contraceptive technique an entry under each of these headings is included in the figures of Table 6.

TABLE 6

*Method of Contraception Used*

| METHOD | WHITE | | NEGRO | | TOTAL | |
|---|---|---|---|---|---|---|
| | Number | Per cent | Number | Per cent | Number | Per cent |
| Condom | 237 | 30.3 | 30 | 21.6 | 267 | 29.0 |
| Douche alone (medicated) | 161 | 20.6 | 58 | 41.7 | 219 | 23.8 |
| Coitus interruptus | 144 | 18.4 | 16 | 11.5 | 160 | 17.4 |
| Douche alone (water) | 129 | 16.5 | 19 | 13.7 | 148 | 16.1 |
| Vaginal suppository | 41 | 5.2 | 4 | 2.9 | 45 | 4.9 |
| Other | 32 | 4.1 | 7 | 5.0 | 39 | 4.2 |
| Safe period | 16 | 2.0 | 4 | 2.9 | 20 | 2.2 |
| Pessary and jelly | 10 | 1.3 | 1 | 0.7 | 11 | 1.2 |
| Pessary and douche | 7 | 0.9 | ... | ... | 7 | 0.7 |
| Pessary alone | 4 | 0.5 | ... | ... | 4 | 0.4 |
| Mechanical intrauterine device | 1 | 0.1 | ... | ... | 1 | 0.1 |
| Totals | 782 | 99.9 | 139 | 100.0 | 921 | 100.0 |

From Table 6 the following points may be noted:

1. The 591 women in this sample who have practised contraception regularly or intermittently have evidently not found any single method generally or permanently satisfactory. Thus the 497 white women admitting some practice of contraception had, in total, a method frequency of 782, giving an average of 1.57 methods per person. For the 94 negro women the method frequency is 139, leading to an average of 1.48. For the whole 591 women the method frequency is 921, giving an average of 1.56 methods tried per person.

2. The three oldest, best known, and in that sense standard methods of contraception, condom, douche, and coitus interruptus, are the most popular among this sample of women. Thus among the white women in the sample 85.8 per cent of the attempted family limitation is chargeable to these three methods together (and including both plain and medicated douches). The percentage rises to the still higher figure of 88.5 among the negro women in the sample. For all the 591 women together the percentage is 86.3. It is plain that the newer and more artistic methods generally advocated by birth-control clinics,[47] have not yet generally reached the group of women from which this sample comes.

3. Both the white and negro groups in this sample favor the douche alone (again counting both the plain and medicated douches together) over all other forms of contraception. The relative (percentage) frequency for this technique is 37.1 for the white group; 55.4 for the negroes; and 39.9 for both groups together. The reason for the racial difference in these percentages is probably a two-fold one. In the first place the negroes in this sample were less addicted to coitus interruptus than the whites. This is what one would expect who knows anything of negro psychology. In the second place the economic factor enters. As a regular contraceptive practice condoms are more expensive than douches even when the latter are medicated. Also they are generally less hedonistically satisfactory to the male partner.

4. In the practice of the methods of contraception listed in Table 6 the male is the responsible party who takes the trouble of limiting the family in the case of two methods (condom and coitus interruptus).

[47] *Cf.* Cooper. *Loc. cit.*, footnote 28; Stopes. *Loc. cit.*, footnote 29; Himes, N. E. Contraceptive methods: The types recommended by nine English birth control clinics. *New England Jour. Med.*, Vol. 202, pp. 866-873, 1930; Dickinson, R. L., and Louise S. Bryant. Control of Conception. An illustrated medical manual. *Baltimore* (Williams & Wilkins) 1931. Pp. xii + 290.

In the use of the "safe period" the responsibility may be roughly said to be divided equally between the two partners to the enterprise. In case of all the other methods the female has to take all the trouble and do all the work of preventing conception. Classifying the relative (percentage) frequencies of Table 6 on this basis it appears that in this sample the white men alone bore 48.7 per cent of the total burden of family limitation; the white couples together on a 50-50 basis 2 per cent of the burden; and the white women alone 49.3 per cent of the burden. The negroes in this sample, however, managed differently. Among them the males assumed only 33.1 per cent of the total responsibility; the couples conjointly 2.9 per cent; and the women alone 64 per cent. Again this result seems to be consilient with negro psychology generally.

### C. *Effectiveness of Contraception as Practiced*

It has been pointed out earlier in this paper that there is often a regrettable failure to distinguish sharply between the *potential* effectiveness of contraceptive methods in the hands of intelligent and careful persons technically advised in birth control clinics or by physicians, and their *actual* effectiveness as practiced in the general population. It is the latter category with which we are solely concerned in this investigation. The data give the entire reproductive histories—and particularly the number and dates of the pregnancies—of two groups of women; the C + women who have tried to prevent conception and the C — women who have made no such attempt. Even if there is some inaccuracy in the records on the C — side, the total amount of attempted contraception in the C — group is insignificantly small as compared with the C + group. The present data, then, permit an answer to this question: Is the rate of occurrence of pregnancy per 100 person-years exposure to risk of pregnancy different in the two groups of women, and if so by what amount and in what direction? A clear-cut answer to this question is the first step necessary to any scientific understanding of the effect of contraception, *as actually practised in the population,* upon the growth of population.

In this first preliminary paper no attempt will be made to give anything more than a rough crude answer to this question. All methods of contraception will be treated together; no attempt will be made to separate regular from intermittent use of contraceptives; no account will be taken of possible differences in the age distribution of the two

groups. The only purpose of presenting any figures now is to give some indication of the trend of the data. It would be obviously foolish to enter upon a refined statistical analysis of the first 2,000 cases alone, when it is probable that there will ultimately be available for such analysis more than 15,000 such cases. In subsequent reports upon the whole mass of material the analysis will go into great detail.

*Exposure to risk of pregnancy.* Owing to the care exercised in the collection of the present data to get precise records of dates it is possible to calculate more refined rates than is usually the case with official statistics. In particular it is possible to determine with considerable precision the exposure to risk of pregnancy. There are two basic physiological postulates here which should be clearly stated. They are:

*a.* A woman past puberty but not past the menopause is assumed to be exposed to risk of becoming pregnant when she is more or less regularly indulging in sexual intercourse, as in the married state.

*b.* A woman, who in all other respects conforms to the specifications of postulate *a* above, is *not* exposed to risk of becoming pregnant during those periods of time in which she *is* already pregnant. It is physiologically impossible for a woman to *become* pregnant while she *is* pregnant.[48]

The figures for "Person-years exposure to risk of pregnancy" given in Table 7 were, then, computed in the following way.

As a first step there is calculated for each women her *individual* total number of years of exposure to risk of pregnancy thus:

*In the case of married women:*

From the total number of years (and fractions of a year[49]) between (from) the date of the woman's marriage and (to) the date of delivery from her last pregnancy there is *subtracted*

0.750 year for each living child she has borne;
0.750 year for each still-born child she has borne;
0.250 year for each spontaneous miscarriage she has had;
0.375 year for each therapeutic abortion she has had;
0.250 year for each other abortion she has had.

These subtractions are made because of the physiological fact that a woman is not at the risk of *becoming* pregnant during the time that she is *already* pregnant.

*In the case of unmarried women (illegitimate births):*

Since the time of the beginning of the illicit sexual intercourse which led to the illegitimate birth is not known, and for obvious reasons cannot usually be accu-

[48] This statement neglects, for practical reasons, the dubious "evidence" for the possibility of the excessively infrequent occurrence of human superfoetation.

[49] Computed from the recorded dates by the use of the table of Pearl and Miner. *Loc. cit.*, footnote 33.

rately found out in an investigation of this kind, it is necessary to make some sort of arbitrary assumption. After careful consideration it has been decided to assume for the present (i. e., until evidence appears for some better figure) that, *on the average*, a woman has been exposed to risk of illicit pregnancy *one year* before the pregnancy begins.

The second step is to obtain the total exposure to risk of pregnancy for the group of women (in this report 2,000 women). This is done by *adding together* the individual figures obtained for each woman in the group in the manner above described.

Since the assumptions made in computing the exposure to risk in the case of illegitimate pregnancies may be thought to be dubious, it has seemed prudent first to set up the results in Table 7 for married women living in wedlock only. There the exposure to risk, and in consequence the rates, have a degree of accuracy greater than has usually been the case in investigations on human reproduction.

From Table 7 the following points are to be noted:

1. The data included in the table comprise in total 6,869.26 person-years exposure of married women to the risk of becoming pregnant, with 5,176 resulting pregnancies. Even though preliminary, this is a respectable body of material. It is roughly equivalent in amount to what one would get in the way of data from observing the reproductive activities of the population of a city of 175,000 to 200,000 inhabitants, say such as Worcester, Mass., for a period of a year.

2. The mean number of years exposure to risk of pregnancy for each married woman exposed in this experience was approximately one year greater for the C+ white women than for the C— white women, and 0.84 of a year greater for the C+ negro women than for the C— negro women. This means that the women in this experience who practised contraception had been longer married on the average than those who did not practise it, since the mean number of years exposure per person is, for married women, the same as the mean number of years married per person *less* the time spent being pregnant. It is possible, though not asserted as a fact on the basis of the present data, that continuing experience of marriage tends to lead to the adoption of contraceptive practices by the married pair. This is a matter which will be analyzed in the final working up of the material.

3. The present data indicate that the average duration of the marriages of women delivered in hospitals in large cities is something upwards of 4 years. This observation is of some interest as indicating

TABLE 7

*Pregnancy Rates per 100 Person-years Exposure to Risk of Becoming Pregnant Among Married Women (a) Who Have, and (b) Who Have Not Used Contraceptive Methods*

*In this Table* C+ *Denotes Women Who Have Regularly or Intermittently Used Contraceptive Methods*
C— *Denotes Women Who are Reported Never to Have Used Contraceptive Methods*

| GROUP | NUMBER OF WOMEN | | PERSON-YEARS EXPOSURE TO RISK OF PREGNANCY | | AVERAGE NUMBER OF YEARS OF EXPOSURE PER WOMAN | | TOTAL PREGNANCIES EXPERIENCED | | PREGNANCY RATE PER 100 PERSON-YEARS EXPOSURE | | MEAN NUMBER OF PREGNANCIES PER WOMAN | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C+ | C— | C+ | C— | C+ | C— | C+ | C— | C+ | C— | C+ | C— |
| White ..... | 493 | 855 | 2,168.77 | 2,940.56 | 4.40 | 3.44 | 1,376 | 2,294 | 63.44 | 78.01 | 2.79 | 2.68 |
| Negro ..... | 88 | 388 | 385.59 | 1,374.34 | 4.38 | 3.54 | 365 | 1,141 | 94.66 | 83.02 | 4.15 | 2.94 |
| Total experience ... | 581 | 1,243 | 2,554.36 | 4,314.90 | 4.40 | 3.47 | 1,741 | 3,435 | 68.16 | 79.61 | 3.00 | 2.76 |

that it is not solely the young bride who seeks the hospital to get through the somewhat terrifying experience of her first confinement.

4. There is no substantial difference between the whites and the negroes in this experience in respect of the mean number of years per woman of exposure to risk of pregnancy.

5. The mean number of pregnancies per married woman (shown in the last column of the table) as experienced throughout the entire reproductive life up to the time of the record, is *higher* for the C+ women than for the C— women, by an insignificant amount in the white group, and by a considerable amount among the negroes. This result, on its face, would seem to indicate that the contraceptive techniques employed by the C+ women had something less than zero effectiveness. Although it is by exactly the same kind of statistical procedure as this that birth control propagandists procure evidence of the effectiveness of their particular techniques, the results cannot be taken at their face value, either in the present case or in theirs. The statistical fallacy lies in the fact that the simple average numbers of pregnancies per woman take no account of differences in exposure to risk in the C+ and C— groups. This leads us to

6. The pregnancy rate per 100 person-years exposure to risk of pregnancy is 14.57 points lower in the C+ group of white married women than in the C— group. That is to say, with the methods of contraception actually practised by the white married women in this sample there was a concomitant reduction in the pregnancy rate per person per unit of time of slightly under 20 per cent below that which obtained in a comparable group of C— women during approximately the same time. This is obviously not a particularly high degree of effectiveness. But it must be again clearly understood that we are not dealing here with theoretical potential effectiveness, but with actual effectiveness, as practised, in and by this group of women. Furthermore, no attempt is made in this preliminary analysis to get at the causes of the relative ineffectiveness of the contraceptive practices in the mass. In some cases it is known to have been due to periodic interruptions of the practice in order to have "wanted" children. In other cases it is known to be due to carelessness and indifference. But in the present preliminary study the only attempt is to indicate roughly the *demographic* effectiveness of contraception in a particular sample of the population, as distinguished from individual instrumental, or technical effectiveness. In short, what we have here is an expression of the

effect which contraception, *as actually practised*, had upon the pregnancy rate of 493 white women, in contrast to the pregnancy rate of 855 white women, of a similar sort and under similar circumstances, who made no attempt to interfere with their natural fertility. The difference is not as great as it might have been predicted to be.

7. In the case of the negro married women the pregnancy rate per 100 person-years exposure to risk of pregnancy is considerably *higher* among the C + women than it is among the C — women.

8. It is of interest to compare the findings set forth in Table 7 with other direct investigations from non-propagandist sources regarding the effectiveness of contraception as actually practised. Davis[80] found in her first questionnaire group of 1,000 women, taken from considerably higher social, educational, and economic planes than the present sample that (p. 16): "the group which used contraceptive measures has a higher average of pregnancies and of children than the group which did not use them." There was, however, no attempt in her study to determine true pregnancy rates, taking account of exposure to risk. For reasons stated above, the average-per-person figures of either pregnancies or children cannot be taken at their face value. Furthermore, probably in association with their higher social-economic status, the women in Dr. Davis' group showed distinctly lower fertility than the women in the present sample, insofar as it may be roughly judged from averages per person. Thus her C + group had an average of 2.50 pregnancies per woman as against 2.79 in the present C + group; and her C — group had an average of 1.65 pregnancies as against 2.68 in the present C — group.

Brown, Greenwood, and Wood[81] dealt with data from 634 married English women of the middle classes, in the English sense—a considerably higher social and economic level than characterized the 2,000 women of the present study. Of these English women 492 had attended a college or university; the remainder, 155 in number, had not; but were, however, sisters or cousins of those who had. In this material it was found that there was (p. 199) "no sensible difference between the size of family in 'limited' [i. e., those in which some form of contraception had been practised] and 'unlimited' marriages."

9. The data of Table 7, as well as the findings of other workers discussed in the preceding paragraph suggest that, in general, women

[80] Davis, Katherine B. *Loc. cit.*, footnote 20.
[81] Brown, Greenwood, and Wood. *Loc. cit.*, footnote 15.

who practise contraception are innately more fertile than women who do not, or than a random sample of women in general. In a recent paper [52] it has been shown that a group of 816 women sent by physicians to a birth control clinic in Baltimore for advice and instructions as to contraceptive methods were considerably more fertile than the general population from which they came. The reasoning on which this conclusion is based is as follows (*loc. cit.* p. 14):

> The 816 women here discussed are a selected, and therefore presumably a differentiated group. They are women who were referred to the Bureau for Contraceptive Advice. The medical records show that in many cases a part of the reasons, which led the patient's physician to send them to the Bureau, was that they had already exhibited unusually high fertility. Just how far these women are differentiated from the general population of married women cannot be exactly determined from any data at present available, but a rough idea about the matter may be had from the following considerations. It is shown earlier in this report that these 816 women had exhibited, on the average, almost exactly one pregnancy for every two years of their married lives up to the time of coming to the Bureau. If a group of married women exhibits an average of one pregnancy in every two years it follows that in any given single year, on the average, about one-half of the women in the group would be expected to be pregnant. There were 173,323 married women aged 15 years and over in Baltimore in 1930. But of these roughly 27.5 per cent were 45 or more years of age. Allowing for this, there are left about 125,660 within the normal reproductive period of life. If all of these had performed at the same rate of fertility as the 816 women who had been clients of the Bureau, it would be expected that about 68,839 of them would have been pregnant during 1930. Deduct 20 per cent of this figure to allow roughly for miscarriages, abortions, etc., and there are left about 50,264 expected births in Baltimore in 1930, on the assumption that all married women in the city are as fertile as the sample of 816, with which we are dealing. Actually the number of births in Baltimore in 1930 was 14,948. Hence it appears from this rough calculation that the women who have come to the Bureau for advice have exhibited a much higher rate of fertility than the general population, perhaps even as much as three times higher, though this would seem to be probably an over-estimate.

Brown, Greenwood, and Wood (pp. 199-200) had the idea that probably the reason for their finding of substantially equal sized families with or without the practice of contraception was "that the women who were naturally of greater than average fertility resorted in greater proportion to the use of artificial means and consequently emerged with an about average fertility." But they go on to state that: "We have failed to obtain any statistical confirmation of this, either by a comparison of fertilities in the first years of marriage (i. e., at an epoch when preventive measures would be less commonly used), or by correlating

[52] Pearl, R. Statistical report of the fourth year's operations of the Bureau of Contraceptive Advice. *Fourth Rept. Bur. Cont. Adv. Baltimore,* pp. 3-15, 1932.

fertility with restriction for health constant. The schedule did not provide for a statement as to when restrictive measures were adopted so that an analysis of fertilities before and after the introduction of preventive measures could not be made."

SUMMARY

1. This paper is a preliminary report on the first 2,000 cases in an investigation of the prevalence and effectiveness of the use of contraceptives in a sample of the American population living in large cities east of the Mississippi. The purpose of the investigation is to get direct, observed evidence of a critical character on a disputed phase of the population problem—namely, the actual as distinguished from either the theoretical or the potential effect of contraceptive practices upon the realization or overt expression of natural fertility in a defined sample of the population. The total mass of material will be much larger when the study is completed. Anything in the way of definitive conclusions now would be premature, and is not attempted.

2. The methodology of the study is a combination of the case method with certain features of the questionnaire method. The data are collected from women undergoing parturition in the obstetric clinics of hospitals, and are obtained and recorded by physicians trained in obstetrics.

3. The 2,000 cases here discussed come almost entirely from the lower economic and social levels; they represent deliveries in 38 different hospitals in five cities, Baltimore, Washington, Philadelphia, New York, and Chicago; 69.5 per cent are whites and 30.5 per cent are negroes; 32.4 per cent of the white women and 26.9 per cent of the negro women had attended high school or some higher institution of learning; 97 per cent of the white women and 78.1 per cent of the negro women were married and living in wedlock.

4. The 2,000 women had experienced during their lives 5,496 pregnancies, or an average of 2.75 pregnancies per woman. For the whites the corresponding figures are 3,731 pregnancies and 2.68 per woman; for the negroes 1,765 pregnancies or 2.89 per woman.

5. Some attempt to prevent conception had been made by 35.8 per cent of the white women, and by 15.4 per cent of the negro women. The corresponding percentages for white married women living in wedlock was 36.6 per cent.

6. The different methods of contraception used were such and were so distributed that, in this sample, the white men alone bore 48.7 per cent of the total burden of family limitation; the white couples conjointly 2 per cent of the burden; and the white women alone 49.3 per cent of the burden. Among the negroes the males assumed only 33.1 per cent of the total responsibility; the couples conjointly 2.9 per cent; and the women alone 64 per cent.

7. A new and more precise method of calculating person-years of exposure to risk of pregnancy is described.

8. The mean number of years of exposure to risk of pregnancy for each married woman exposed was, in this experience, approximately one year greater for the C + (contraception practised) white women than for the C — (contraception not practised) white women, and 0.84 year greater for the C + negro women than for the C — negro women.

9. The mean number of pregnancies per married woman as experienced throughout the entire reproductive life up to the time of record was *higher* for the C + women than for the C — women in this sample, by an insignificant amount in the white group and by a considerable amount among the negroes.

10. The pregnancy rate per 100 person-years exposure to risk of pregnancy is 14.57 points lower in the C + group of white women than in the C — group. In other words the methods of contraception actually practised by this group of married white women were accompanied by a reduction in the pregnancy rate per person per unit of time of only about 20 per cent below that which obtained in a comparable group of C — women during approximately the same time.

11. In the case of the negro married women in this sample the pregnancy rate per 100 person years exposure to risk of pregnancy is considerably *higher* among the C + women than it is among the C — women.

12. There is some reason to think, though it is not yet demonstrated, that women who practise contraception are innately more fertile than women who do not, or than a random sample of women in general.

# SIDELIGHTS ON THE POPULATION PROBLEM IN JAPAN*

BY THOMAS J. LEBLANC

The population problem, or rather the relation between total population and its growth on the one hand, and food production on the other, has reached the point in Japan where the question is demanding, and obtaining, the attention of even the highest governmental authorities. Suggested solutions of the difficulty, such as increased food supply, emigration, etc., are not viewed so optimistically at present as they were a few years ago. The essential relationship in the problem is the position of the population with reference to the food supply that is available. In most discussions of the problem this essential relationship is tacitly admitted to be the crux of the situation and it is implied that its solution will avoid difficulties, many of which are international in character. However, it is doubtful if more than a few international disagreements could possibly be charged directly to the need on the part of one of the disputants to an immediate supply of food. The problem of food supply in Japan has been treated more or less fully by various writers, whose conclusions are, in the main, academic, and in the face of which we find the practical fact that imports of food continue to increase. It is quite probable that Japan could accommodate a certain increase in population, say thirty to fifty per cent, provided the per capita consumption of food did not increase markedly, and do this by utilizing resources within her own borders such as full exploitation of Hokkaido, cultivation of hillsides, using unpolished rice and decreasing or eliminating the use of grains for alcoholic beverages and the substitution of mineral fertilizers for green crops and fish now used for such purposes. All of these changes have possibilities, but none is being effected at a speed that gives rise to optimism among students of the problem. Korea and Formosa do not offer much for the future, because their indigenous populations are increasing at a rather rapid rate and this rate of increase tends to become greater under Japanese administra-

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tion. However, even with a rapidly increasing population, an increasing per capita consumption and a relatively slower increase in the production of food in Japan, it is certain that not more than a handful of people actually suffer from lack of food at the present time. It must not be concluded from this that the pressure of expanding population on a constant area is not making itself felt. And this brings up the point that, in spite of food being the final determinant, nevertheless there are other variables that it may be well to consider.

With advances in so-called civilization, life has been made more complex so that it is possible that demands added by this complexity may produce symptoms of population pressure somewhat in advance of the point where population is actually straining at the facilities for the supply of food. A recognition of these prodromal symptoms might serve to define a given population problem before it had reached the stage where it was a question of food or starvation.

Present day life makes it necessary that a nation have more than food and shelter. There must be capital, power and raw materials in view of the rapid industrialization that is taking place among the leading nations. With industrialization comes the possibility that population pressure will exhibit itself in the relation between demand and supply of raw materials rather than foodstuffs, and at the same time in a demand for markets, unless the population is able to consume within its own numbers, the industrial products. Japan is a striking example of such a situation. The Chinese boycott against the purchase of industrial products produced in Japan demanded action just as surely as would have a blockade that prevented the arrival of rice in Japan. And it is probable that the attempts to extend the Japanese Empire into Manchuria are efforts to acquire an absorbing market for industrial products.

Population pressure is the result of an interplay of stresses set up by the increasing demand of expanding numbers for the resources that come either from the surface of the earth, underground, or from the seas that may surround the area in question. And this pressure cannot be expressed accurately in densities as persons per unit area or even persons per unit of arable area, since the demands are determined in large measure by what the numbers in the population group consider essential to comfort or security. Thus a density of 100 persons per unit area might represent a low pressure in one place and the same density might be intolerable in another place which differs only in its

demands; these in turn are determined by a different social mindedness reflected in an increase in those things considered as necessities.

### THE IMPORTANCE OF FUEL IN AN INDUSTRIAL ECONOMY

There is a distinct and fundamental difference in the sources of the different resources of any nation, and this distinction is becoming greater in importance with the increasing demands brought about by industrialization. Briefly the difference is that, in the case of the surface of the earth and the seas surrounding any area, the products furnished in one unit of time can be duplicated in another unit, since these products are the result of life processes that may be induced or permitted to continue themselves by reproduction, whereas the products that come from underground represent withdrawals that are continually depleting a fixed deposit without, at present, any hope of re-deposit. This is to be remembered when discussing minerals and fuels, the latter representing power, excepting water power, which is a surface phenomonon not necessarily unfavorably affected by utilization. And as time carries us further and further into the industrial era, power becomes more and more the determining factor and positively correlated with national wealth and the so-called standard of living; and it seems that these in turn lead inevitably to the moulding of international policies. The important phase of this relationship from the standpoint of population pressure is the increasing demand for *underground* products, which may be translated into an increasing per capita demand for industrial products, i. e., power and raw materials.

In this paper it is proposed to present data for Japan arranged in such a way that the various variables may be compared with the growth of population on the basis of time. Only those variables will be treated where reasonably accurate information can be had, and it is not to be construed that those presented are considered the most important nor that more than a few angles of the problem can be treated, but rather that the facts selected represent the most accurate ones and those that extend over the longer periods of time. No attempt will be made to determine whether any given trend is desirable or whether it makes for an enhancement or reduction of population pressure. In view of the scarcity of accurate data and our lack of knowledge of the real effects of various variables in the population pressure system, such an attempt would be idle. The trends are presented with the suggestion that they do represent symptoms of population pressure and that they

are necessarily related to the increase of numbers on a relatively constant area, whatever may be the indirect channels through which they make themselves apparent.

Japan is a case of more than usual interest because population pressure is relatively acute and because it represents a nation that in the short space of little more than a half century has changed from a purely agricultural nation to one that is fast becoming increasingly industrialized. This is shown by the facts set forth in Table 1. Cities whose population is 50,000 or more may be considered as resulting primarily from industrial activity. The numbers and total population of such cities were taken from official publications and the ratio of this urban population to the total population was found. The year 1886 was taken as a base and the increasing ratio of urban population referred to that base. For purposes of comparison, total population was treated in like manner, the result being two index numbers, one showing the growth of total population and the other showing the growth of the *percentage of urbanization*. It is to be noted that the latter index is different from

TABLE 1

*Showing Populations in Japan for the Years as Indicated for Cities of 50,000 or More, and the Total Population with the Resulting Percentage of Urbanization, with the Latter Two Values Placed on an Index Basis for Comparison. The Decrease in Urban Population for 1920 is Due to the National Census with its Attendant Accuracy in Count. Data are Taken from the Annual Reports of Statistics of Japan for the Respective Years. Figures for 1886-1898, Legal Population; 1903-1918, Official Estimates; 1920 and 1925, Census Counts. Total Population for 1930 is now Available but Urban Population has not been Completely Tabulated.*

| YEAR | NUMBER OF CITIES | TOTAL POPULATION OF CITIES | TOTAL POPULATION OF COUNTRY | PER CENT OF URBANIZATION | URBANIZATION INDEX | TOTAL POPULATION INDEX |
|---|---|---|---|---|---|---|
| 1886 | 12 | 2,437,891 | 38,507,177 | 6.3 | 100 | 100 |
| 1888 | 14 | 2,956,118 | 39,607,234 | 7.5 | 118 | 103 |
| 1893 | 18 | 3,304,414 | 41,388,313 | 8.0 | 126 | 107 |
| 1898 | 20 | 4,270,391 | 43,763,855 | 9.8 | 154 | 114 |
| 1903 | 25 | 5,546,622 | 46,588,000 | 12.0 | 188 | 121 |
| 1908 | 29 | 6,889,400 | 49,318,300 | 14.0 | 221 | 128 |
| 1913 | 35 | 7,667,206 | 52,911,800 | 14.5 | 228 | 137 |
| 1918 | 45 | 9,491,496 | 55,662,900 | 17.1 | 269 | 145 |
| 1920 | 41 | 8,518,672 | 55,963,053 | 15.2 | 240 | 145 |
| 1925 | 55 | 11,106,542 | 59,736,822 | 18.6 | 294 | 155 |

one showing the growth of urban population and the difference between the two trends is less when the percentage index is used. Inspection of the table shows that during the time 1886-1925 the percentage of urbanization increased 2.9 times while during the same time, total population increased 1.5 times. In other words the percentage of urbanization has increased 1.8 times faster than has the total population. This may be regarded as a measure of the rate of urbanization and is interesting in view of the fact that the rate of increase of total population in Japan is relatively high, i.e. 55 per cent in 40 years. For practical purposes, urbanization is synonymous with industrialization.

### NATIONAL DEBT

National debt is a collective expression of individual liability of the members making up the total population. It is not an exact measure, since it does not include changes in national assets, but on the other hand there is usually an unfavorable trend to the buying power of a unit of money over a time base, which might absorb a considerable amount of increase in national assets. Crude as the measure is, it is of some significance, since national liability must be discharged eventually and this can be done only by the action of power, either man or machine,

TABLE 2

*Showing National Debt, Population, and Debt per Capita for Japan for the Years as Indicated. Population and Debt per Capita Have Been Reduced to Index Numbers. The Data are Taken from the Annual Reports of Statistics for Japan for the Respective Years*

| YEAR | NATIONAL DEBT IN MILLIONS OF YEN | TOTAL POPULATION IN THOUSANDS | NATIONAL DEBT IN YEN PER CAPITA | POPULATION INDEX | DEBT PER CAPITA INDEX |
|---|---|---|---|---|---|
| 1875 | 142 | 34,338 | 4.14 | 100 | 100 |
| 1880 | 358 | 36,359 | 9.85 | 106 | 238 |
| 1885 | 329 | 38,151 | 8.62 | 111 | 208 |
| 1890 | 306 | 40,453 | 7.58 | 118 | 183 |
| 1895 | 420 | 42,271 | 9.94 | 123 | 240 |
| 1900 | 510 | 44,826 | 11.38 | 131 | 275 |
| 1905 | 2,093 | 47,678 | 43.91 | 139 | 1,061 |
| 1910 | 2,780 | 50,985 | 54.53 | 148 | 1,317 |
| 1915 | 2,658 | 54,936 | 48.38 | 160 | 1,169 |
| 1920 | 4,066 | 57,919 | 70.21 | 169 | 1,696 |
| 1925 | 5,429 | 62,045 | 87.50 | 181 | 2,114 |
| 1930 | 8,132 | 64,447 | 126.16 | 188 | 3,392 |

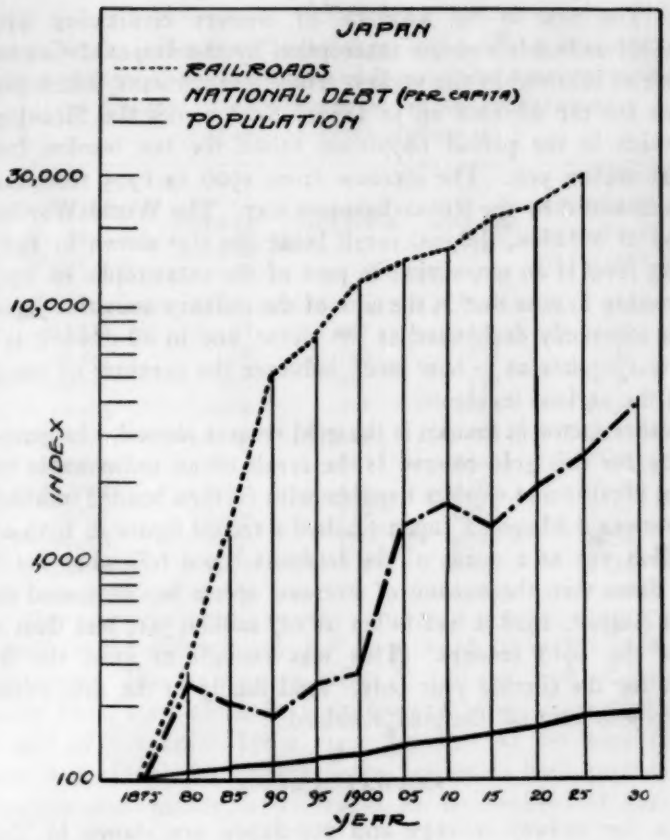


FIG. 1. INDICES OF INCREASE OF RAILROADS, NATIONAL DEBT PER CAPITA AND POPULATION OF JAPAN FROM 1875 TO 1930

on land or raw materials. The figures are exhibited in Table 2 and for purposes of comparison are reduced to the form of indices. A graphical presentation is shown in Figure 1, which is plotted on a logarithmic scale so that slopes for the same time period in the different trends are comparable. The table shows that during the years 1875-1930 the per capita debt has increased more than 33 times while the population was increasing 1.9 times. While some of this represents money borrowed to develop public utilities and these earn profits, it is notable that the larger increments follow or are coincident with national activity of a different nature. These larger increments fall under five main

heads. The first is the adoption of western civilization with the building of railroads and the assumption by the Imperial Government of the debts incurred by the various feudal governments, which probably accounts for the increase up to 1880. Next comes the Sino-Japanese war, which in the period 1890-1900 raised the tax burden from 80 to 2,200 million yen. The increase from 1900 to 1905 represents the increment added by the Russo-Japanese war. The World War brought a period of inflation, the end result being the rise shown to 1920, and the 1925 level is an expression in part of the catastrophe of 1923. It is interesting to note that in the case of the military activities Japan was what is commonly designated as the victor, and in all cases it is interesting to speculate as to how much influence the pressure of population had on the various incidents.

Another factor in finance is the gold reserve abroad. In general the necessity for this gold reserve is the result of an unfavorable relation between imports and exports together with foreign bonded indebtedness. The overseas holdings of Japan reached a record figure in 1919 of over one billion yen as a result of the business boom following the World War. Since then the amount of overseas specie has decreased steadily until in August, 1928 it had fallen to 127 million yen, less than 10 per cent of the 1919 amount. This was enough to meet the interest charges for the coming year only. And finally in the first months of 1932 the yen went off the gold standard.

### RAILWAY MILEAGE

Data for railway mileage and population are shown in Table 3. Index values are included in Figure 1. The table shows a rapid increase in railway mileage as compared with the increase in population. Of course at the time the railways were first installed there was a population of roughly 35 millions that had to be served. Reference to the last column of the table, showing the ratio of increase of each period over the preceding one, suggests that this original population was served possibly by 1890 and probably by 1895. From that time expansion in mileage has been presumably to meet the demands of growth of population, and it will be noted that the ratio of rail increase is always greater than the ratio of population increase; in this connection it is even possible that the ratio of rail increase does not reflect the exact demand but is modified downward by financial conditions. It is obvious that there is an upper limit for rail expansion, but what that limit will be is

TABLE 3

*Showing Populations, Railway Mileages, Index Values for Both and Mileage per Million of Population with the Rate of Increase, for Japan for the Years as Indicated. Data Taken from the Annual Report of Statistics of Japan, Volume 46*

| YEAR | POPULATION IN THOUSANDS | RAILWAY MILEAGE | POPULATION INDEX | MILEAGE INDEX | MILES PER MILLION OF POPULATION | RATIO OF INCREASE OVER PREVIOUS PERIOD |
|---|---|---|---|---|---|---|
| 1875 | 34,338 | 38 | 100 | 100 | 1.11 | .. |
| 1880 | 36,359 | 98 | 106 | 258 | 2.70 | 2.4 |
| 1885 | 38,151 | 351 | 111 | 922 | 9.20 | 3.4 |
| 1890 | 40,453 | 1,698 | 118 | 4,460 | 41.97 | 4.5 |
| 1895 | 42,270 | 2,290 | 123 | 6,015 | 54.17 | 1.3 |
| 1900 | 44,825 | 3,855 | 131 | 10,124 | 86.00 | 1.6 |
| 1905 | 47,678 | 4,783 | 139 | 12,560 | 100.32 | 1.2 |
| 1910 | 50,985 | 5,354 | 148 | 14,061 | 105.01 | 1.0 |
| 1915 | 54,936 | 7,435 | 160 | 19,526 | 135.34 | 1.3 |
| 1920 | 57,919 | 8,475 | 169 | 22,256 | 146.33 | 1.1 |
| 1925 | 62,045 | 10,884 | 181 | 28,583 | 175.42 | 1.2 |

influenced by the difference in rail increase as compared with population increase. The increase in miles of rail per unit of population, especially from 1905 onwards, is an example of an increasing demand by a unit of population for a given factor. At the same time this increase in facilities for transportation has made both population and food supply more mobile, which makes for an evenness of distribution.

### IRON AND STEEL

Figures for iron and steel are not available over a long period of time, but the trend of consumption since 1908 is shown in Table 4, which indicates that in the short space of time between 1908 and 1926 the *consumption* has more than doubled while the population was undergoing roughly a twenty per cent increase. The important facts in connection with the demand for iron and steel are that Japan is seriously handicapped by the lack of ores of good quality, the higher wage level as compared with China or India and the imperfect technical development as compared with the United States of America, whose pig iron and other iron products enter freely in the face of a high protective tariff. Thus there is little or no hope that Japan, from her own de-

TABLE 4

*Showing Iron and Steel Consumption for Japan for the Years as Indicated, Reduced to an Index Number with the Index of Population Growth for Comparison. Data for Iron and Steel Consumption Represent Production Plus Imports Minus Exports and are Taken from the Japan Year Book for the Respective Years*

| YEAR | TONS | IRON AND STEEL INDEX | POPULATION INDEX |
|---|---|---|---|
| 1908 | 596,494 | 100 | 100 |
| 1913 | 892,112 | 150 | 108 |
| 1921 | 855,574 | 143 | 118 |
| 1922 | 948,081 | 158 | 120 |
| 1923 | 1,043,824 | 174 | 122 |
| 1924 | 1,368,371 | 229 | 123 |
| 1926 | 1,308,473 | 219 | 127 |

posits, can satisfy the demand of even the present population. The nearest and largest deposits outside of Japan are in China, and this fact may have a great influence in shaping Japan's policy in the Far East.

## COAL AND OIL

Japan is poor in coal. There is no anthracite, and the bituminous that is mined is relatively expensive, about twice the price of the same in the United States. This is due to several factors, among them being the distance between the fields and the industrial centers. Thus the freight on coal from the northern island of Hokkaido to Tokyo represents half of the Tokyo price. In addition there is a lack of loading facilities and the relatively low efficiency of Japanese workmen, either inherent in the men or caused by natural difficulties of working seams or the impossibility of using machine methods of extraction. At any rate, cost of extraction is mounting rapidly. This point probably has a direct bearing on the rapid development of hydro-electric power.

In the case of petroleum, it appears not only that the supply is small but that it is fast becoming exhausted. The output of Japanese wells has steadily declined since 1917, and at the same time the consumption of both crude oil and the refined products has increased markedly, which necessarily forces imports upward. The rate of increase can be judged from the fact that in the time between 1922 and 1926, a short span of only five years, the imports of gasoline rose from 11 million to 28 million gallons, lubricating oil went from 8 to 25 million gallons,

whereas fuel oil, exclusive of that used by the Navy, went from 4 to 120 million gallons. This is an excellent example of the increasing complexity of population demands, which not only introduces the demand for an entirely new factor but may rapidly increase the rate of consumption of that factor. An elderly man in Japan may not have utilized a gallon of gasoline in the course of his whole lifetime, whereas an equal quantity is used by his son in the course of an hour.

A special phase of the Japanese fuel problem is the fuel used for domestic purposes, which is almost exclusively charcoal. Obviously it takes longer to grow a tree than it does to burn the charcoal made from that tree, so that it is probable that in the not too distant future either the demands of increasing population will have exhausted the supply of wood used in making charcoal or the sources of supply will be so far removed from the centers of consumption that the price will be forced upwards; and it would seem not unlikely that expanding numbers will soon place the charcoal supply under a definite strain that will be reflected among the poorer classes of people unless a different fuel, say the low grade coal briquette, is substituted.

### HYDRO-ELECTRIC POWER

Due to a happy combination of mountainous topography and heavy rainfall that persists throughout the year over the main portion of the

TABLE 5

*Showing Electric Power in Generator Capacity for the Years as Indicated. Data are Taken from the Annual Report of Statistics of Japan, Vols. 41 and 46. Rate of Growth is Indicated in the Indices. Index for Population Growth for the Same Period of Time Changed from 100 in 1907 to 127 in 1925*

| YEAR | GENERATOR CAPACITY IN KWTS. | INDEX | YEAR | GENERATOR CAPACITY IN KWTS. | INDEX |
|---|---|---|---|---|---|
| 1907 | 114,910 | 100 | 1916 | 805,289 | 701 |
| 1908 | 154,733 | 135 | 1917 | 875,563 | 762 |
| 1909 | 182,216 | 159 | 1918 | 983,966 | 856 |
| 1910 | 257,537 | 224 | 1919 | 1,133,243 | 986 |
| 1911 | 321,564 | 280 | 1920 | 1,377,546 | 1,199 |
| 1912 | 462,203 | 402 | 1921 | 1,526,718 | 1,329 |
| 1913 | 596,856 | 519 | 1922 | 1,779,173 | 1,548 |
| 1914 | 715,969 | 623 | 1923 | 2,062,785 | 1,795 |
| 1915 | 771,584 | 671 | 1924 | 2,237,503 | 1,947 |
| | | | 1925 | 2,768,141 | 2,409 |

country, Japan is rich in water power, and the coal and oil situation has forced a rapid development of hydro-electric works. The trend of this development can be seen in the figures of Table 5. These express the generator capacity by years, but since the capacity each year expands over the previous year it is reasonable to suppose that little time elapses between the erection of a generator and the complete utilization of its capacity. In other words and generally speaking, it is assumed that generator capacity is identical with consumption. While the population was increasing by 25 per cent, capacity for generating electric power increased 24 times. A point to be noted when considering these trends is that not only will the per capita demand increase but the sources available for supplying that demand will become increasingly difficult to tap and hence the cost will mount. The most accessible and cheapest sources are the ones first developed, and later development must move into a more costly field of exploitation. That there will be an increasing demand for power, provided raw materials are available, is suggested by Table 6, which shows the development of factories and the increase in number of factory workers. This is another expression of the rate of industrialization of Japan. While population was increasing by two-fifths, factory workers increased over three times and the number of factories increased over six times. This would indicate a growth of smaller factories, since the number of factories increased more rapidly than did the number of workmen.

TABLE 6

*Showing the Development of the Number of Factories and of Factory Workers in Japan for the Years as Indicated. Both have been Reduced to Indices with the Population Index Given for Comparison. Data for 1920 and 1925 were Taken from Present Day Japan, 1928, and for 1900, 1905, 1910 and 1915 from the Annual Report of Statistics for Japan, Vol. 38*

| YEAR | NUMBER OF FACTORIES | NUMBER OF WORKERS | FACTORY INDEX | WORKER INDEX | POPULATION INDEX |
|---|---|---|---|---|---|
| 1900 | 7,824 | 422,019 | 100 | 100 | 100 |
| 1905 | 9,776 | 587,851 | 134 | 139 | 106 |
| 1910 | 13,523 | 717,161 | 186 | 170 | 114 |
| 1915 | 16,809 | 910,799 | 231 | 216 | 123 |
| 1920 | 45,806 | 1,554,427 | 629 | 368 | 129 |
| 1925 | 48,819 | 1,669,116 | 670 | 396 | 138 |

MISCELLANEOUS

In addition to the tangible factors already mentioned there are certain other variables that do not lend themselves easily to quantitative measurement but are none the less of interest. Among these may be listed the question of tenantry disputes. As the cost of living rises and the pressure of numbers begins to strain land area, it is almost inevitable that discord develops between land owners and land workers. As land becomes more difficult to acquire, the land owner must extract from his land a relatively higher return to cover not only the original cost but in addition the current taxation, which will also rise. The land worker at the same time is faced with an increase in the cost of living. Land can be induced to increase its yield up to a certain point, but beyond that point there is bound to be trouble. This stage has already been reached in Japan, and not only is the tenantry dispute problem recognized but no reasonable and practical solution seems to be forthcoming, a not unexpected situation. In addition to this phase of the land question there is the expansion of urban areas, which not only makes inroads on food producing areas but gives rise to an unemployed class of workers who know nothing but farming and who no longer have land to farm. Some of these are absorbed into industry, but many are not. Those that are add to the rising demand for raw materials and power and ultimately to the urgency for an export market.

Generally speaking, the same forces that strain the relationship between land owner and land worker act in a like manner between employer and employee, so that there is an increasing number of disputes each year between these two classes with an increasing number of persons being involved each year. Quantitative data on these disputes cannot be interpreted, since the real significance of any given dispute is not necessarily directly proportional to the number of persons involved. And still another variation of the same question is the fact that as population increases without outlet there is an added competition for employment and the worker is apt to find himself displaced, while relatively young, by a still younger man. Under the same general heading comes the housing problem. The renter not only finds the cost of living advancing, as it is bound to when the internal supply fails to meet the demand, but he also finds that as time goes on he pays a larger and larger percentage of his income for housing.

A minor but interesting symptom of high population pressure is the relatively excessive mortality caused by natural catastrophes. When

people are crowded together closely any phenomenon of violence kills or injures large numbers simply because they were, of necessity, at that particular place when the event occurred. Thus in Japan it is not uncommon to read of four or five persons being killed in a single electrical storm, simply because no matter where the lightning strikes there is a fair chance that somebody will be there at the time. And almost every time a river overflows its banks, part of the cost is reckoned in human lives.

Finally there is the vexing question of emigration. Population pressure makes the situation and any increase in pressure serves to aggravate it, and as world population increases the possibilities for solution of any one problem will inevitably become fewer. The fact that a need for emigration arises is reasonably clear evidence that pressure within the population group has reached a point where its effects are either unpleasant or undesirable to the members making up that group. From an international standpoint it is probable that the need for emigration is the most important prodromal symptom of high population pressure though it appears that at the present time the symptom is so late in manifesting itself that little can be done in the way of amelioration.

With the points touched on in this paper clearly in mind it would appear that Japan's action in Manchuria and China is not unexpected but rather an inevitable result flowing out of certain trends that have been part of the national picture for many years. It is doubtful whether Japan is in the process of solving her problem but it is equally doubtful whether anyone can offer the correct solution.

# THE CHURCHES AND SOCIAL WELL BEING*

BY JOHN R. MINER

From the point of view of human biology religion is both an individual, personal reaction pattern, and also a group phenomenon. Regarded in the latter aspect it is an organized element, or variable, in the general integration called society. The basic structural elements of organized religion are the churches (sects, denominations). There is a common tendency to regard the churches, not only as bulwarks of morality and social stability, but as agencies which promote social well being in general. This is naturally a favorite theme of the clergy, but it is also a common enough opinion among those who have no professional interest in believing it.

To test the validity of such assumptions is not an easy matter, and few attempts have been made in this direction. Bonger (1) found for the Netherlands and Murchison (9) for the United States that a larger proportion of the criminal classes than of the general population claims membership in some church. On the other hand, Dunn's (7) results were conflicting: in one group of prisons there was a larger proportion, in another group a smaller proportion, of church members than among the population at large. It has also been shown (8) that in the United States there is little correlation between the percentage of church members in the population of a state and the commitments for various crimes. On the whole, these results do not suggest that the churches show any great efficiency as guardians of morality.

## WEALTH

What of their broader rôle of promoting social well being? One important element in this is economic well being, which may be measured roughly by wealth per capita. Fortunately, the Bureau of the Census estimates the value of all tangible property in each state, and these estimates for 1922 are given in the *Statistical Abstract of the United States 1926* (2). Similarly, the number of church members in each state is given in the *Census of Religious Bodies 1926* (4). We have thus

* From the Department of Biology of the School of Hygiene and Public Health of the Johns Hopkins University.

official figures on which to base interstate correlations between percentage of church members and wealth per capita. These are as follows: All religious bodies, $-0.226 \pm .094$; Roman Catholics, $+0.217 \pm .094$; Methodists and Baptists, $-0.733 \pm .046$. $PE_o$, the probable error of a sample of the same size from an uncorrelated parent population, is 0.099. The correlation of wealth per capita with percentage of church members in general and of Roman Catholics is thus insignificant, while that with Methodists and Baptists is negative and definitely significant. In other words, states with large proportions of total church members and of Roman Catholics have populations neither richer nor poorer than those of states having smaller proportions of church members. On the other hand, those states having considerable proportions of Methodists and Baptists in their populations exhibit low wealth per capita. And conversely states exhibiting high wealth per capita tend to have only a relatively small proportion of Methodists and Baptists in their population. The closeness of this inverse relationship is indicated in Figure 1.

There is nothing in these results to indicate that the churches promote economic well being.

### EDUCATION

Another important aspect of social well being is the state of education of the population. What effect do the churches have on this? Pearl (10), on the basis of trends in the growth of the churches, found that an inverse relation was suggested by his data between the vigor of the churches and the general intellectual and cultural level of the population. Will correlational methods contradict or confirm this result? The Bureau of the Census has published (5) the percentage of illiterates in each state at the Census of 1930. The interstate correlations of illiteracy with percentage of church members are as follows: All religious bodies, $+0.191 \pm .096$; Roman Catholics, $-0.079 \pm .098$; Methodists and Baptists, $+0.715 \pm .048$. $PE_o = 0.099$. The first two correlations are insignificant, while the third is positive and definitely significant. In other words, states in which church members as a whole and Roman Catholics form a large proportion of the population are neither more nor less literate than their less devout neighbors, while illiterates abound in the Methodist and Baptist centers.

But the percentages of illiteracy which we have used refer to all classes of the population. Now the foreign-born whites, who are most numerous in the North-Eastern states and the Negroes, who are most

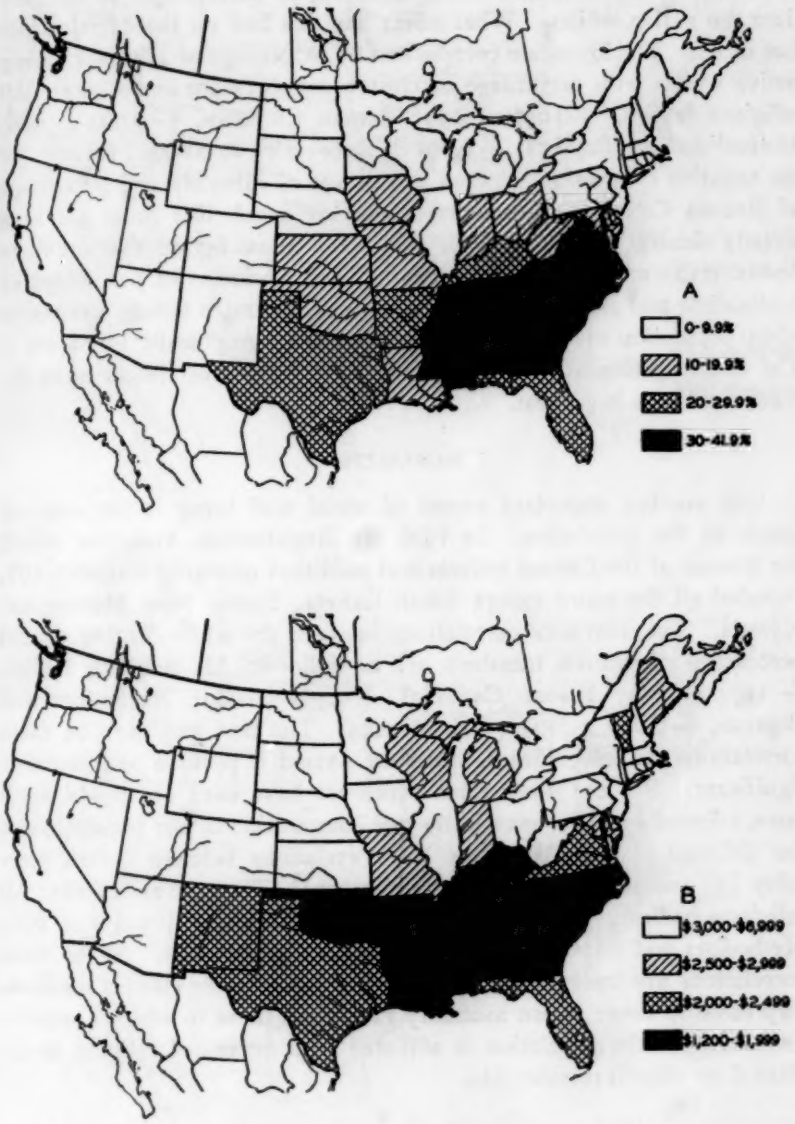


FIG. 1. A. MAP OF THE UNITED STATES SHOWING THE PERCENTAGES OF METHODISTS + BAPTISTS TO TOTAL POPULATION IN THE DIFFERENT STATES. B. MAP OF THE UNITED STATES SHOWING THE DISTRIBUTION OF WEALTH PER CAPITA.

numerous in the Southern states, show higher percentages of illiteracy than the native whites. What effect has this had on the correlations? Let us see. The interstate correlations of percentage of illiteracy among native whites with percentage of church members are as follows: All religious bodies, $+0.057 \pm .099$; Roman Catholics, $-0.364 \pm .086$; Methodists and Baptists, $+0.795 \pm .036$. $PE_o = 0.099$. Except for the negative correlation between percentage of illiteracy and percentage of Roman Catholics, these correlations are much like those we have already obtained. There is little evidence in these figures that the more devout states are the better educated. The association of percentage of Methodists and Baptists and percentage of illiterates among the native white population of the various states is shown graphically in Figure 2. The concentration of Methodists and Baptists and of illiterates in the Southern states is evident.

### MORTALITY

Still another important aspect of social well being is the state of health of the population. In 1928 the Registration Area, for which the Bureau of the Census collects and publishes mortality statistics (6), included all the states except South Dakota, Texas, New Mexico and Nevada. The interstate correlations between the white death rate and percentage of church members are as follows: All religious bodies, $+0.035 \pm .105$; Roman Catholics, $+0.393 \pm .089$; Methodists and Baptists, $-0.229 \pm .099$. $PE_o = 0.105$. The first and third of these correlations are insignificant, while the second is positive and probably significant. But the death rates which we have used are crude death rates, affected by differences in the age composition of the population of the different states. What are the correlations between infant mortality (3) and percentage of church members? They are as follows: All religious bodies, $-0.031 \pm .103$; Roman Catholics, $+0.092 \pm .102$; Methodists and Baptists, $+0.097 \pm .102$. $PE_o = 0.103$. All of these correlations are insignificant. The states with higher church membership have no lower infant mortality rates than those in which a smaller proportion of the population is affiliated with organized religion as indicated by church membership.

### SEXUAL MORALITY

We have seen that states in which the churches, in general, are vigorous are no healthier, no wealthier, and no more literate than states

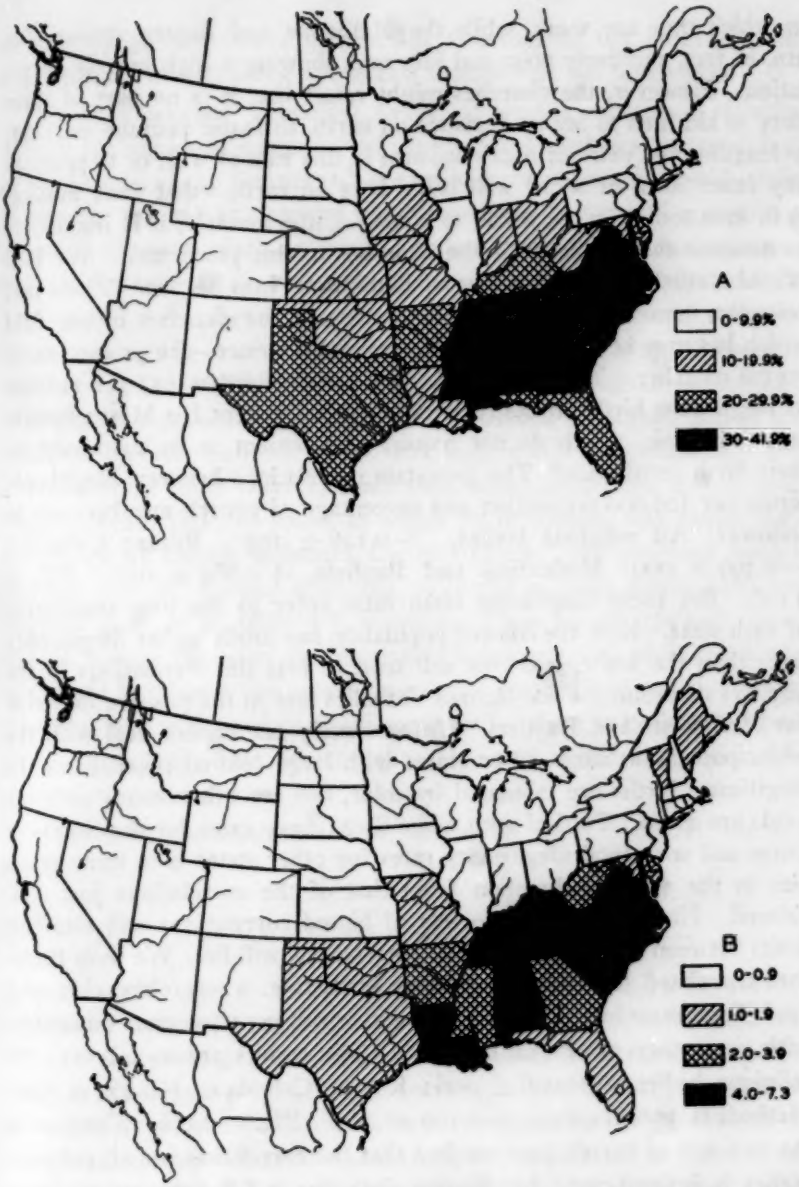


FIG. 2. A. PERCENTAGE OF METHODISTS AND BAPTISTS IN THE VARIOUS STATES: 1926. B. PERCENTAGE OF ILLITERATES AMONG NATIVE WHITES IN THE VARIOUS STATES: 1930.

in which they are weak, while the Methodist and Baptist strongholds are, in fact, relatively poor and illiterate, showing a high inverse correlation. However, the churches might retort that it is no part of their duty to aid men to lay up treasure on earth, to foster profane learning, to lengthen the years of man's sojourn in this vale of woe, or to promote any other form of social well being here on earth,—that their mission is to save souls for the world to come. Unfortunately, it is impossible to measure the efficiency of the churches in this pious task. We lack official statistics on the number of immigrants into heaven. There are, however, numerical indexes of the success of the churches in one field which has ever been esteemed their especial province—the promotion of sexual morality. The Bureau of the Census publishes (3) the number of illegitimate births in the registration states, except for Massachusetts and California, which do not require a statement as to legitimacy on their birth certificates. The interstate correlations between illegitimate births per 100,000 population and percentage of church members are as follows: All religious bodies, $+0.146 \pm .104$; Roman Catholics, $-0.390 \pm .090$; Methodists and Baptists, $+0.864 \pm .027$. $PE_o = 0.106$. But these illegitimate birth rates refer to the total population of each state. Now the colored population has much higher illegitimacy rates than the white, and this will tend to bias the correlations in the negative direction for the Roman Catholics and in the positive direction for Methodists and Baptists. Unfortunately one cannot deal with the white population alone. For states with large colored populations the illegitimate births are tabulated by color, but for other states only the totals are given. To deal with white illegitimacy rates for the Southern states and with total illegitimacy rates for other states is to introduce a bias in the opposite direction from that of the correlations just considered. However, these two sets of biased correlations will establish limits between which the unbiased correlations will lie. We have therefore correlated the white illegitimate birth rate, where obtainable, and total illegitimate birth rate for states in which no separation was made, with percentage of church members. The results are as follows: All religious bodies, $+0.036 \pm .106$; Roman Catholics, $+0.062 \pm .106$; Methodists and Baptists, $+0.100 \pm .105$. $PE_o = 0.106$. Comparing the two sets of correlations we find that the correlation for all religious bodies is insignificant; for Roman Catholics it lies between an insignificant positive and a moderate negative value; for Methodists and Baptists, between an insignificant and a high positive value. So far as

we may judge from these figures, the churches do not seem to have much success in promoting the sexual morality of the population.

There is another numerical index of sexual morality available. Among the causes of death for which mortality statistics are published by the Bureau of the Census (6) are syphilis, its sequelae, tabes dorsalis (locomotor ataxia) and general paralysis of the insane, and gonococcus infection, diseases which are mainly spread through extramarital copulation. The interstate correlations of the death rate from these venereal diseases and percentage of church members are as follows: All religious bodies, $-0.082 \pm .102$; Roman Catholics, $-0.170 \pm .100$; Methodists and Baptists, $+0.460 \pm .081$. $PE_o = 0.103$. But again the colored have higher venereal death rates than the whites, and again deaths are tabulated by color only for states with large colored populations. The correlations of white venereal death rate, where obtainable, and of total venereal death rate for states in which no separation was made, with percentage of church members are as follows: All religious bodies, $-0.225 \pm .098$; Roman Catholics, $+0.268 \pm .096$; Methodists and Baptists, $-0.448 \pm .082$. $PE_o = 0.103$. Thus for all religious bodies and for Roman Catholics the correlation is insignificant, while for Methodists and Baptists it lies between moderate positive and negative limits. As with the correlations of illegitimate births, there is nothing in these figures to indicate that the churches play any significant part in the promotion of sexual morality.

The writer is indebted to Dr. Raymond Pearl for criticism and advice.

## SUMMARY

States with large proportions of church members are on the average no healthier, no wealthier, and no more literate than states in which the churches are weak, and show no lower illegitimate birth rates or venereal death rates. States with large proportions of Methodists and Baptists are relatively poor and illiterate. So far as these results go, there is no indication of any effective contribution of the churches (the overt, recognized representatives of organized religion) to social well being, so far as the latter may be regarded as indicated by the variables here studied, namely per capita wealth, literacy, health, and sexual morality.

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# NOTES

## DISEASE OF THE UPPER RESPIRATORY TRACT (COMMON COLD) IN JEWS AND NON-JEWS*

". . . . just as racial characteristics extend to the forms and agglutinations of the red corpuscles of the blood, so also there is a considerable mass of evidence pointing to racial liabilities to, and immunity from particular diseases." (1, p. 75)

That the Jew is peculiarly susceptible to and relatively immune from particular diseases is frequently recorded. Thus Rolleston (2), in his comparison of Jews and non-Jews in respect of certain diseases, refers to cerebromacular degeneration, thrombo-angiitis obliterans, and Gaucher's and Niemann's diseases as appearing earlier in life and with greater severity among Jews. The same author also states that diabetes mellitus has a greater incidence in Jews, that uterine cancer is rare in Jewesses, and that the mortality rate from tuberculosis is much lower among Jews.

A review of the literature revealed no material dealing with disease of the upper respiratory tract (common cold) in Jews. It is the purpose of this paper to determine if there is a difference between a group of Jews and a group of non-Jews in respect of *1.* frequency, *2.* severity, and *3.* type of attack of common cold. The basic material is from the John J. Abel Fund for Research on the Common Cold, and the persons, a part of whose records are used, were students of the School of Medicine or students or staff members of the School of Hygiene and Public Health. The period of observation consists of two academic years, 1929-1930 and 1930-1931, of thirty-five weeks each. During the first year 48 Jews and 295 non-Jews were observed. As a result of dropping the School of Hygiene and Public Health group, the graduation of the fourth year medical class, and the registration of a new class, this population was reduced at the beginning of the second year to 43 Jews and 220 non-Jews. For methods and other details, the reader is referred to the publications of the Abel Fund.

* Supported by a grant from the John J. Abel Fund for Research on the Common Cold. Paper No. 171 from the Department of Biostatistics, School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, Md.

OBSERVATIONS OF 1929-1930

*Frequency of Attack.* Table 1 gives the distribution of the number of attacks of disease of the upper respiratory tract (common cold) reported during the thirty-five weeks by the Jews and the non-Jews, respectively. Forty-eight per cent of the first group reported less than three attacks and 33 per cent reported more than three; of the second group 48 per cent reported less than three attacks and 25 per cent reported more than three. There is no significant difference between the two groups in respect of frequency of attack.

TABLE 1

*Distribution of Attacks of Disease of the Upper Respiratory Tract (Common Cold) Reported During Thirty-five Weeks by (1) Jews and (2) Non-Jews*

| NUMBER OF ATTACKS | JEWS | | NON-JEWS | |
|---|---|---|---|---|
| | Number | Per cent | Number | Per cent |
| 0 | 4 | 8.3 | 28 | 9.5 |
| 1 | 7 | 14.6 | 46 | 15.6 |
| 2 | 12 | 25.0 | 68 | 23.1 |
| 3 | 9 | 18.7 | 80 | 27.1 |
| 4 | 12 | 25.0 | 44 | 14.9 |
| 5 | 3 | 6.2 | 13 | 4.4 |
| 6+ | 1 | 2.1 | 16 | 5.4 |
| Total | 48 * | 100 | 295 † | 100 |

* These reported a total of 127 attacks.
† These reported a total of 774 attacks.

*Severity of Attack.* Four indexes of severity were chosen: in bed, general aching, fever, and duration of ten or more days. Table 2 shows the frequency (per cent) of attacks classified according to these indexes, reported during the thirty-five weeks by the Jews and the non-Jews, respectively. The two groups present no significant difference in respect of any one of the four indexes of severity of attack.

*Type of Attack.* Table 3 exhibits the frequency (per cent) of attacks classified according to type, reported during the thirty-five weeks by the Jews and the non-Jews, respectively. The two groups show no significant difference in respect of any one of the different types of attack.

OBSERVATIONS OF 1930-1931

Tables 4, 5 and 6 are concerned with the frequency, severity, and type of attack, respectively, experienced by the two groups of persons

TABLE 2

*Frequency (Per cent) of Attacks of Disease of the Upper Respiratory Tract (Common Cold) Classified According to Certain Indexes of Severity, Reported During Thirty-five Weeks by Three Hundred and Forty-three Persons (1) Jews and (2) Non-Jews*

| INDEX OF SEVERITY | PERCENTAGE OF 127 ATTACKS REPORTED BY JEWS | PERCENTAGE OF 774 ATTACKS REPORTED BY NON-JEWS |
|---|---|---|
| In bed | 9.4 | 14.0 |
| General aching | 10.2 | 15.1 |
| Fever * | | |
| First 48 hours † | 18.9 | 13.8 |
| Later | 7.9 | 7.2 |
| Duration 10 + days | 52.8 | 58.9 ‡ |

* Includes persons stating that they had fever whether or not a thermometer was used.
† That is, on the first or second day of illness, or both.
‡ Unknown for 1 case.

TABLE 3

*Frequency (Per cent) of Attacks of Disease of the Upper Respiratory Tract (Common Cold) Classified According to Type, Reported During Thirty-five Weeks by Three Hundred and Forty-three Persons (1) Jews and (2) Non-Jews*

| TYPE OF ATTACK * | PERCENTAGE OF 127 ATTACKS REPORTED BY JEWS | PERCENTAGE OF 774 ATTACKS REPORTED BY NON-JEWS |
|---|---|---|
| Cor.+, C—, ST— | 16.5 | 18.0 |
| Cor.+, C+, ST— | 13.4 | 13.0 |
| Cor.+, C—, ST+ | 26.0 | 23.6 |
| Cor.+, C+, ST+ | 38.6 | 39.9 |
| Cor.—, C+, ST+ | 0.8 | 1.4 |
| Cor.—, C+, ST— | 0.8 | 1.3 |
| Cor.—, C—, ST+ | 3.9 | 2.7 |
| Presence of: | | |
| Coryza | 94.5 | 94.6 |
| Cough | 53.5 | 55.7 |
| Sore Throat | 69.3 | 67.7 |

* Cor = coryza (sneezing, nasal discharge, nasal obstruction, and/or inflammation or watering of the eyes); C = cough; ST = sore throat (pharynx, nasopharynx, tonsils and/or trachea); + = present; — = absent.

TABLE 4

*Distribution of Attacks of Disease of the Upper Respiratory Tract (Common Cold) Reported During Thirty-five Weeks by (1) Jews and (2) Non-Jews*

| NUMBER OF ATTACKS | JEWS | | NON-JEWS | |
|---|---|---|---|---|
| | Number | Per cent | Number | Per cent |
| 0 | 2 | 4.7 | 18 | 8.2 |
| 1 | 12 | 27.9 | 39 | 17.7 |
| 2 | 12 | 27.9 | 50 | 22.7 |
| 3 | 10 | 23.3 | 53 | 24.1 |
| 4 | 5 | 11.6 | 41 | 18.6 |
| 5 | 1 | 2.3 | 17 | 7.7 |
| 6 | 1 | 2.3 | 2 | 0.9 |
| Total | 43 * | 100 | 220 † | 100 |

* These reported a total of 97 attacks.

† These reported a total of 559 attacks.

TABLE 5

*Frequency (Per cent) of Attacks of Disease of the Upper Respiratory Tract (Common Cold) Classified According to Certain Indexes of Severity, Reported During Thirty-five Weeks by Two Hundred and Sixty-three Persons (1) Jews and (2) Non-Jews*

| INDEX OF SEVERITY | PERCENTAGE OF 97 ATTACKS REPORTED BY JEWS | PERCENTAGE OF 559 ATTACKS REPORTED BY NON-JEWS |
|---|---|---|
| In bed | 23.7 | 24.9 |
| General aching | 16.5 | 19.3 |
| Fever * | | |
| First 48 hours * | 23.7 | 18.1 |
| Later | 7.2 | 11.4 |
| Duration 10 + days | 47.4 | 58.9 |

* Defined in Table 2.

TABLE 6

*Frequency (Per cent) of Attacks of Disease of the Upper Respiratory Tract (Common Cold) Classified According to Type, Reported During Thirty-five Weeks by Two Hundred and Sixty-three Persons (1) Jews and (2) Non-Jews*

| TYPE OF ATTACK * | PERCENTAGE OF 97 ATTACKS REPORTED BY JEWS | PERCENTAGE OF 559 ATTACKS REPORTED BY NON-JEWS |
|---|---|---|
| Cor.+, C—, ST— ..... | 23.7 | 17.5 |
| Cor.+, C+, ST— ..... | 12.4 | 10.4 |
| Cor.+, C—, ST+ ..... | 20.6 | 22.9 |
| Cor.+, C+, ST+ ..... | 37.1 | 44.5 |
| Cor.—, C+, ST+ ..... | 5.2 | 1.4 |
| Cor.—, C+, ST— ..... | 0.0 | 0.0 |
| Cor.—, C—, ST+ ..... | 1.0 | 3.2 |
| Presence of: | | |
| Coryza ..... | 93.8 | 95.3 |
| Cough ..... | 54.6 | 56.4 |
| Sore Throat ..... | 63.9 | 72.1 |

* Defined in Table 3.

during the academic year 1930-1931. None of these tables presents a significant difference.[1]

SUMMARY

Forty-eight Jews and 295 non-Jews were observed during the academic year 1929-1930, and 43 Jews and 220 non-Jews were observed during the academic year 1930-1931. Every effort was made to secure reports of all attacks of disease of the upper respiratory tract (common cold).

The Jews and the non-Jews of either academic year showed no significant difference in respect of (1) frequency, (2) severity, or (3) type of attack of disease of the upper respiratory tract (common cold).

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WILLIAM M. GAFAFER

[1] A consideration of the differences between the experiences of the two academic years forms part of a paper which is in preparation.

# ERRATUM

The following was omitted in the paper—"Apical Dystrophy: An inherited defect of hands and feet," by J. W. MacArthur and Dr. Ernest McCullough, in HUMAN BIOLOGY, Volume IV, No. 2, May, 1932, page 205, and is to precede the last paragraph.

## CONCLUSIONS

Apical dystrophy of fingers and toes is characterized by a variable failure of development of the terminal portions of fingers II to IV and, to a less degree, of the corresponding toes. An incidental effect of this reduction is a frequent and variable deficiency of the nails and finger print patterns.

The first digits are usually not shortened, but the thumbs show in most cases a broadening with some doubling or twinning of the terminal phalanx, involving more or less of the bone, nail, and flesh.

A fleshy webbing occurs sporadically among abnormals of the family, especially between digits III and IV.

# RECENT LITERATURE

USEFUL IN THE STUDY OF HUMAN BIOLOGY

In this department will be noticed the books and reprints which are currently received at the Editorial Office. Publications intended for notice here should be addressed to Dr. Raymond Pearl, Department of Biology, School of Hygiene and Public Health, 1901 East Madison Street, Baltimore, Maryland, U. S. A.

## 1. EVOLUTION AND GENETICS

### 1. *Evolution—General Principles*

JOHNSTONE, JAMES. The Essentials of Biology. *New York* (Longmans, Green and Co.), 1932. Pp. xv + 328. 5⅜ × 8½ inches. $4.50.

MCCLELLAN, WILLIAM H. A recent Catholic book on evolution. *America*, Vol. XLVII, pp. 87-89, 1932.

NEWMAN, HORATIO H. Evolution Yesterday and Today. *Baltimore* (The Williams and Wilkins Co.), 1932. Pp. x + 171. 5 × 7¼ inches. $1.00.

ROSTAND, JEAN. L'Évolution des Espèces. Histoire des Idées Transformistes. *Paris* (Librairie Hachette), 1932. Pp. 203. 4¾ × 7½ inches. 12 francs (paper).

THOMSON, SIR J. ARTHUR. Purpose in Evolution. Riddell Memorial Lectures, Fourth Series. Delivered Before the University of Durham at Armstrong College, Newcastle-on-Tyne, on November 4th, 5th, and 6th, 1931. *New York* (Oxford University Press), 1932. Pp. 59. 5⅜ × 9 inches. 75 cents (paper).

### 2. *Human Evolution*

BLACK, DAVIDSON. Evidences of the use of fire by *Sinanthropus*. *Bulletin of the Geological Society of China*, Vol. XI, pp. 107-108, 1931.

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